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Mental and Chronological Age Problems in Law and Medicine*

*David Shakow, Ph.D., Bethesda, Md.***

As a psychologist, I am called upon to consider some of the psychological factors that the law ought to take into account when making its judgments about persons in this area. I am not sure that it is the place of any specialist to say, as a specialist, what ought to be done about social problems. This is a matter mainly for the citizen (the specialist himself included in this role) and his delegated representatives to decide. At most the individual expert may say: "On the basis of specialized study, these appear to be the relevant factors which should be kept in mind in coming to a decision." In the present instance, where we are concerned with the factors that play a role in the consideration of legal problems, what the psychologist may say is that so far as our present knowledge goes, people have such and such characteristics that appear important in this context, or preferably, this *person* has these psychological characteristics that deserve consideration. It must then be left to the law to decide what importance should be placed upon these data in the context of the rest of the evidence.

I should like, from the beginning, to emphasize that in this difficult area of human evaluation most of the data that we have suffer from some degree of tentativeness. Our knowledge is largely based upon only limited study and experimentation. Even when the body of data is in absolute amount, large, it is still limited when compared with the study required

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by the complexity of the field. Even where considerable attention has been given to a topic, the questions that remain unanswered are much greater than those for which we have at least some partial answer. In relation to the material which I shall present, then, certain probable errors—speaking statistically—attach to my statements. Daily life does not permit us to put off decisions while we wait for a final answer, granted that such an answer were ever possible to get. Since at any particular moment the law is called upon to take some action, we are compelled to do so on the basis of the incomplete but best knowledge available. I shall, therefore, try to present what appears to be generally accepted as the best present answer, "the best" as I have been able to glean it from the study of both my own and others' data.

In the area under consideration, we are concerned primarily with the factors in the *nature* of man that play a role in certain aspects of his behavior, and only secondarily with the *situational* aspects of the responses of persons. The latter is a most important problem in itself. Because of the inextricable way in which both aspects are connected, I shall, of course, have to concern myself to some extent with this problem also. I shall do so, however, only in passing. When I say "nature" I do not mean to imply the point of view that certain types of constitution are inevitably linked with certain acts which result in conflict with the law or are otherwise of legal significance. I am saying, rather, that when a crime is committed, or when a person in some other way becomes involved with the law, certain aspects of his psychological functioning, those thought of as being *primarily* internal and relatively enduring, must be examined in order to determine what part these may have played in the presenting problem.

Such an approach means that I shall not concern myself with categories of persons. I shall rather emphasize the *individual*. We are not interested, for instance, in the relationship that feeble-mindedness as a category of persons has to crime, or whether feeble-minded persons are more likely to commit crimes. Instead, when given an instance of conflict with the law, we ask what psychological factors in the individual, of which feeble-mindedness is only one, may have contributed to this conflict? Both approaches are, of course, important, but in the setting of this discussion the approach

from the standpoint of the individual appears to me to be the one calling for consideration.

After these preliminary remarks, let us return to the subject: *Mental and Chronological Age Problems.* It is obvious when a psychologist discusses this topic that his interest in chronological age problems would not stem from a concern with the physical and physiological changes that are involved in aging, but rather from an interest in the mental characteristics of the person as they are affected by age. We shall therefore consider mental and chronological age as these are inter-related. Actually it is, of course, the quality of the *mental* functioning of the person that is of primary interest. Age itself interests us only as one of the *many* factors influencing mental functioning.

At this point I wish to take up some fundamentals—to make explicit certain basic principles with regard to psychological functioning which would otherwise remain only implicit in our discussion and might therefore lead to some unclarity. I have reference to four important factors especially relevant to us: (1) Variation; (2) Functioning in relation to capacity; (3) Continuity of the distribution; (4) Complexity of psychological function. These may sound formidable when stated thus baldly, but they really represent simple concepts as we shall see when we consider each separately.

Let us start with the first: *Variation.*

In discussing chronological and mental age simultaneously, as we do so frequently, we make the assumption that certain mental age characteristics are associated with certain chronological ages. In the ordinary course of events this is approximately true. We must recognize, however, that chronological age itself, even though we use it in glib fashion as, for instance, when we say that X is fourteen years old or Y is sixty-three years old, is really not so simple a concept as such use would indicate. At least it is not so simple if we wish to imply by these statements anything more than a *very* rough notion of what we may be led to expect of the person so designated. In effect, about the only thing that *is* simple about these statements is that fourteen or sixty-three years, respectively, have elapsed since birth. If there is any indication from studies in *all* areas of biological knowledge, it is the

important one that *variation*—difference—exists. This variation is of two kinds. One is called *inter-individual* variation, and refers to the fact that no two people in the same group are exactly alike on the characteristic being investigated, and that a randomly selected group distributes itself widely on the same characteristic. The other, called *intra-individual* variation, points to the fact that no individual is absolutely the same on the same characteristic at different times. So when we say: "This person is twenty years old," aside from describing fairly accurately the length of time in years that he has lived, we are only in approximate fashion indicating what he is really like either physically or mentally—the range of functioning within a particular age range is so marked. It is this fact of group variation that has led to both the commonsense and scientific substitution of *mental* for chronological age.

Besides this very great range among persons falling into the same category, there is ordinarily a considerable range of function *within* the individual. With rare exceptions, however, this range is much less than in the group. Some of this variation within the individual is considered to be "fundamental biological variation." It appears to be true that living organisms, by the very fact that they are alive, cannot manifest an unchanging level of functioning in any characteristic. Slight variations in the organism's functioning are found whenever we measure it. Besides this kind of variation, which we can in ordinary daily affairs disregard, there is a kind of intra-individual variation that is created by changes of special kinds, either by conditions within the organism or by situations to which the organism is exposed from the outside. It therefore becomes necessary for us to know the *conditions,* both internal and external, in which the person is reacting, as well as his *characteristic level* of reaction. The serious problems of *post-factum* evaluation and retroactive characterization becomes involved here as it is in other aspects of the problem which we shall later consider. I refer, of course, to that most difficult task of determining from *present* characteristics what the person was like at the moment when the legally relevant problem arose.

I have mentioned one important principle which it is necessary for us to keep in mind, that of the range of the distribu-

tion of characteristics. I now wish to call attention to another important principle which is consistently present in psychological studies. This has to do with the problems related to *capacity* and its expression. When we talk rigorously in psychology about the capacity of the person, we mean the level of performance which he can potentially reach under *optimal* conditions. We must recognize, of course, that it is a level that is achieved by a person only under very exceptional circumstances. Ordinarily, performance at capacity level remains a theoretical possibility rather than attains the stage of realization. The pressure of life is rarely great enough to require our functioning at this level and it seems probable that, from a fundamental biological point of view, capacity function was never intended to be used except as reserve for emergencies. Under ordinary day-by-day conditions the normal person uses only part of his capacities, and it is this level of partial capacity functioning that we see expressed when he is working at normal efficiency. This is essentially the level we tap when we examine him psychologically, although some of our tests give us hints about what the person's potential capacities are. In evaluating a person we are therefore thrown back to considering his *typical* level of response, rather than his potentially highest one. You thus see the complications that one runs into psychologically, when one asks the simple question: "Was he capable of this or that?"

Still another important principle is that which involves the *continuity of the distribution* of functions. In most biological characteristics, when we examine a particular sample of the population, we find that the characteristic is roughly distributed in what has been called a normal curve, a curve that is bell-shaped in form. People cannot be divided up into discrete, sharply differentiated groups on these characteristics. They distribute themselves rather in a moreness or lessness of a characteristic, gradually shading off one from the other, so that it becomes most difficult to distinguish one person from his neighbor, except in some arbitrary quantitative way. We do not have just blacks and whites; we have all the shades of gray in between. It is only between the extremes of a distribution of persons that we can make sharp differentiations. This fact is most important when it comes to making practical

decisions. What we do ordinarily is to break up the natural continuity—the neighborliness of the distribution—by setting arbitrary points of division. We then act as if we were passing into a quite different area when we go from one side of the dividing line to the other. For example, we designate persons with I.Q.'s of 70 and below as feeble-minded, and those with 71 and above as lying outside that classification. We must constantly keep in mind that this is only a division made for practical and convenient purposes. Scientifically, such a division does not have any validity. That is, a person having an I.Q. of 72 is much nearer a person having an I.Q. of 69 than is a person of I.Q. 55 to one of 69. Still, the latter two are placed in the same category for social purposes, whereas the former two are separated tremendously so far as the social action that we may take is concerned. We shall have occasion to consider this point again later.

The fourth general principle which I should like to consider is that of the *complexity of function* which is covered by the apparently simple terms that we use. Perhaps I can make my point clear by considering "mental age." When we say that the mental age of a person is sixteen, we are using a term which has value in some settings, but which can be seriously misleading in others. The most we should mean by this characterization is that the person is functioning at the general total mental level of a sixteen-year-old as measured by tests. This is so because "mental age" is a composite term which represents a general characterization of mental functioning, a kind of averaging characterization which eliminates the marked differences in subfunctions which may be involved in the same mental age. Mental age really involves a complex of psychological functioning and includes learning ability, memory, reasoning, perception and a number of other such characteristics. The mental age score is merely a summation and an averaging of the functioning in these various areas. Since psychological functions, though closely tied together, are not necessarily highly associated with each other, one can have a person with very good memory function and relatively poor reasoning function, and a person with the opposite characteristics, both coming out in the end with essentially the same mental age score. Although sometimes the global score is satisfactory, for many practical situations it is of the utmost

importance to know the *profile* of the functions which go to make up the particular mental age score rather than merely the global mental age. We may, for instance, be particularly interested in how much dependence to place upon a person's memory ability and be little concerned with his ability to reason.

It is against this background of the complexities which are involved that we must consider what the law is frequently called upon to say: "Above this level we accept functioning as 'normal' and can place responsibility upon the person for his acts." There have been marked differences, I understand, in the levels set up at different times by the law. Hale, in the 17th century, suggested the "understanding of a child of fourteen years" as a test. Fitzherbert appears to have had much lower standards. His "Twenty-Pence Test" says: "And he shall be said to be a sot, an idiot from his birth, . . . who cannot account or number twenty pence." This would presumably set the level at half the age set by Hale—at about seven years. (The Binet Test calls for the ability to count 13 pennies at the six-year level.) Another test of Fitzherbert's, "Telling how old he is," would by our present standards be placed at an even lower level, namely, five years. Present practice seems to be to set the level of responsibility somewhere in between—at about ten years. This is the mental age level below which we ordinarily consider persons feebleminded.

Having laid down this dividing point, the law is now interested in evaluating the individual case to determine whether or not the particular person falls below the level which it is willing to accept as normal. It must, however, be further interested in the *factors* which have an effect on lowering function below this level in order to know when to be on the lookout for the possibility that one of these conditions has existed in the particular instance.

Before examining this aspect, however, it is necessary to point out that the problem is even *more* complex than we have thus far indicated. Because of the particular task assigned me, I limit myself to a consideration of only one aspect of mental life; namely, that which is generally known as the *cognitive* or the intellectual. Actually, we know that in relation to problems in which the law is interested, *affective* fac-

tors, that is the degree of emotional development of the person and the nature of his emotional response, and *conative* factors, those relating to the carrying out of actions, are both integrally related to the cognitive, the knowing side of the personality. These may be of equal or even greater importance than the last. I shall, however, limit myself to the consideration of the intellectual (cognitive) aspects and consider deficit in function as related to this relatively narrow interpretation of what we mean by mental age. Because of this, my discussion will concern itself with data with which the psychologist, rather than the psychiatrist, has been mainly concerned.

If we examine the factors which may play a role in determining the presence of defect we find that they fall into two major categories: the *endogenous,* those arising from internal factors, and the *exogenous,* those arising from external factors.

In the endogenous group, we have two major sources of defect. The first is *age,* which itself presents two types of defect: too little age and too much age! The first, of course, is *youth,* the state deriving from purely chronological factors of not having matured sufficiently in the intellectual sphere to reach a level which, so far as the law is concerned, might be called "normal adult understanding." The other is *senescence,* a natural and apparently inevitable deterioration of intellectual processes which takes place increasingly with aging beyond a certain optimum point. If we were to draw a graph of the characteristic which we call mental age, we would have a curve with an upward steep rise from birth to about sixteen, a flattening of the curve through the twenties and a gradual decline after that, through senescence to death. We shall consider this problem in some detail shortly.

Among the endogenous factors, the major area besides age is that which has variously been called feeble-mindedness, amentia, mental defect, etc.—all terms designating a state of low intelligence apparently existing from birth, a condition sometimes considered hereditary. We need not here enter the controversy over this point. What *is* essential for our purposes is the recognition of the fact that persons of this kind develop more slowly than the ordinary run of people and

reach varying levels of development—all retarded, however. If we speak in *very* rough terms we may say that at the best they reach levels up to approximately three-quarters of the intellectual endowment of the average person.

We may now turn to the other category of factors influencing defect, the *exogenous*. These arise from outside influences which tend in one way or another to disturb an existing, presumably normal, constitution. These factors are of quite varied kinds. We might first consider birth injury. This involves an injury to the brain during the process of birth which results in defect of levels similar to those found in intrinsic feeble-mindedness. Approximately one case in twelve of feeble-mindedness may be related to this factor. Damage to the brain at later periods in life, whether in childhood or adulthood, coming from accident or disease, may also result in definite intellectual defect. Long-continued drug and alcohol addiction may have a deteriorating effect on psychological function. Certain physical diseases, such as syphilis, also apparently have a lasting effect on psychological function. In both these latter instances, however, many more studies are necessary before any definitive statements can be made. Certain forms of mental disorder, which according to our present knowledge, do not necessarily involve brain injury, also have such effects. The group of exogenous factors we have just been discussing have a lasting effect on the intellectual functions of persons. I do not wish to imply that these are necessarily permanent defects, in the sense of being irreversible, but it appears safe to say that they at least persist for substantial periods of time and in some instances are actually irreversible.

In addition to this group of relatively permanent exogenous factors, there is another group of such factors where the disturbing effect on psychological function is only of a *passing* nature. Some of these are of the same type as those found in the previous group, but do not result from a long-continuing condition. Thus, an isolated instance of alcoholic or drug indulgence may temporarily affect psychological function. A disturbed emotional state, not involving in any way a mental disorder, may have an effect on cognitive function. Temporary deprivation of oxygen may for a time affect psychologi-

cal function. Fatigue may result in deficiency of function. Any of these, as well as many other conditions, may affect functioning temporarily.

What seems to arise from a consideration of these various factors—both the intrinsic and the extrinsic, the permanent and the passing—is the implication that it is important for us not only to know the fundamental, underlying functioning capability of the person—what he ordinarily has available in the way of resources for dealing with life's problems—but it is also important for us to know what he has *immediately* available functionally for dealing with a particular situation which he has to meet when he is handicapped in any of the ways we have mentioned. The dangers inherent in retroactive evaluation are here further emphasized.

I cannot, of course, review the findings in all of these areas. I shall, however, select evidences from different areas and try to exemplify the working of the four principles—variation, capacity, continuity, complexity—as they reflect themselves in the findings. The extent of the defect created by the condition may be represented in global terms, that is, in a mental age score, or, in differential terms—as it affects certain psychological functions but not others.

Let us take first the results obtained from the study of persons of different age levels. I emphasize this area because we are here involved in problems closest to the normal and for that reason it is at the same time both the easiest and the most difficult to understand. We have already considered the nature of the curve for total mental age—a rise to about the sixteenth year, a flattening, and then a decline. We should now consider another aspect of this problem, namely, the differential slopes of the various functions represented in a total test. We might take, as an example, some findings on the Bellevue scale (3), an individual test of intelligence made up of eleven different types of sub-tests designed to tap different aspects of intelligence. When (cf. Figure I) we compare the curves of the average performance on two of the sub-tests for the semi-decades from twenty through sixty, we find the following: A test of information (essentially a test of memory for material learned in the past) shows practically no decline through this age range, whereas the digit-symbol test (a test which calls for the learning of new material, the association of certain digits with certain geometric patterns) shows a

gradual decline in performance—up to a maximum of about 40% at age 60. Thus, we see a very marked difference in the differential effect of age upon memory for old material when compared with the learning of new material.

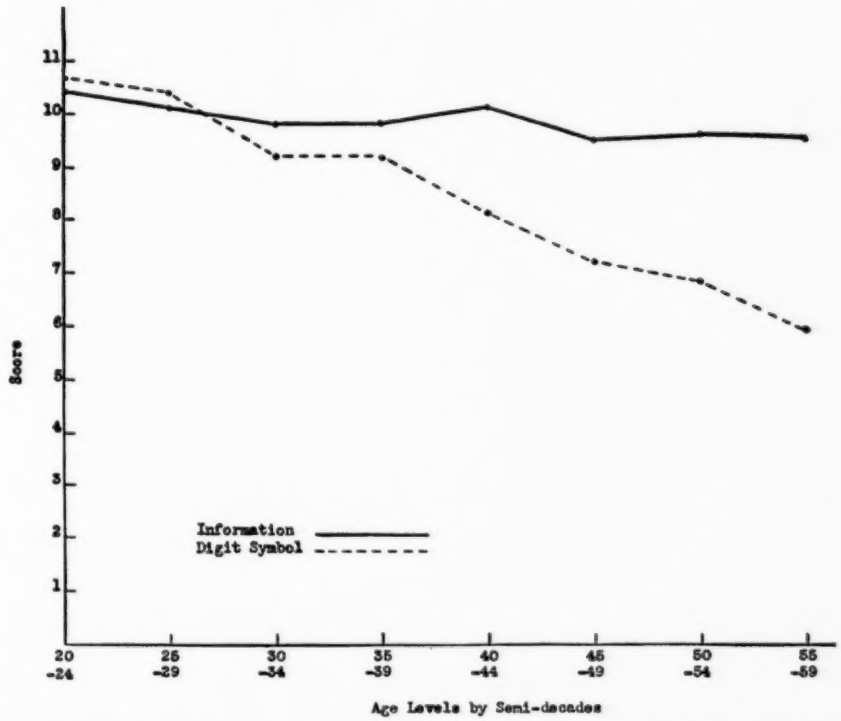

Figure I—Age Scores on an Old (Information) and a New (Digit Symbol) Learning Test of the Bellevue Scale

Let us go to another area—the efficiency in perceiving materials such as letters, numbers or colors (1). When we examine (cf. Table I) the scores obtained by persons from ages sixteen through ninety for material presented for only one-tenth of a second what do we find? A very marked, downward trend in efficiency as indicated by the mean scores as age increases beyond the twenty-five to twenty-nine year level. (It should be pointed out that all of these persons were fitted properly with glasses if they needed them so that visual defect as a factor was eliminated.)

TABLE I.—Influence of age on visual perception span and speed (Group results from Price for a total of 684 males and females)

Age groups	Number of cases	Mean scores	S. D's.	Age groups	Number of cases	Mean scores	S. D's.
6–7.....	3	59.2	18.7	40–44...	45	105.0	17.7
8–9.....	17	75.0	18.5	45–49...	44	103.4	19.8
10–11...	12	90.8	18.5	50–54...	60	99.5	21.9
12–13...	38	103.0	13.9	55–59...	53	88.6	21.5
14–15...	24	106.1	15.9				
16–17...	24	115.0	17.9	60–64...	52	90.2	19.8
18–19...	18	111.7	16.0	65–69...	52	82.5	20.8
				70–74...	39	75.0	20.5
20–24...	41	109.9	14.3	75–79...	23	68.0	22.9
25–29...	39	111.2	19.3				
30–34...	45	102.8	16.7	80–84...	10	52.0	16.8
35–39...	43	106.6	18.7	85–89...	2	55.0	10.0

Or to take still another example: Several years ago we studied (2) the functioning of a group of normal persons of the age range from fifteen through ninety, on two types of memory material, and the extent of their vocabulary (cf. Figure II). We found that the vocabulary level remains constant to age seventy, and only then shows a drop, whereas, the recall of other types of material also learned considerably earlier ("old recall") begins to show a drop beginning markedly at approximately age fifty. The recall of immediately learned material ("new recall") is most markedly affected—the decline beginning at the twenty year level. "Old recall" involves memory of items which are over-learned, material that has been learned in childhood and on which there has been considerable practice throughout life—although usually not as much practice as in vocabulary. "New recall" involves remembering material which has been learned immediately before recall is asked for. It involves remembering sentences, pictures, digits, and similar material. An interesting aspect of our study is to be found in the scores obtained by two groups of quite disturbed patients in the same test. One of these groups consisted of persons suffering from senile psychosis and the other of those suffering from cerebral arteriosclerosis—the two great mental diseases of old age. We found that the actual deterioration in memory which comes with age itself is proportionately more marked than that which comes with having a mental disease of either of these rather severe types! On the other hand, vocabulary level seems to be

affected relatively much more by these diseases than by age. On the basis of these findings, it would appear that most of the disturbance in memory, a disturbance which appears so

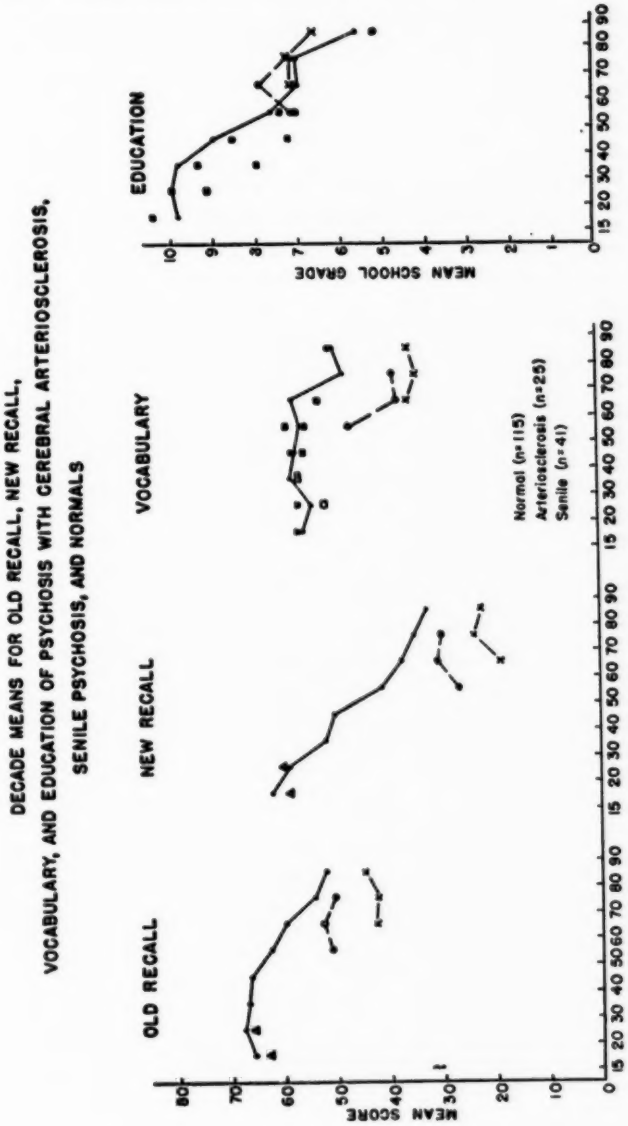

Figure II

markedly in psychotic aged persons, is to be accounted for in considerable extent by the normal disturbance which comes with age itself, rather than by the disease from which they are suffering.

This would seem to be the appropriate point at which to raise an important question. The law is concerned with the competence of a person to carry out certain acts and with the responsibility that can be placed upon him for these acts. If a person falls below a certain level, then he is presumably not competent and not responsible. It may perhaps be said that in relation to this problem one is essentially not interested in the history of the person insofar as it relates to his competence at other times. The major interest is in how competent he was at the time of the action. We might point out that in the past judgments in this matter have generally been made on an empirical rule-of-thumb basis, which took into account the person's age, his occupation, how well he carried out his responsibilities, and other data of this kind. Only occasionally have evaluations indicating the mental level of the person been obtained from formal psychological studies. I have described many more complications in the problem as seen by the psychologist in addition to those already taken into account in ordinary practice. These former complications have sometimes been recognized implicitly but have never been faced openly and specifically. The question we must now face is: What do psychologists have to contribute to handling the problem?

The question is quite legitimate and I wish psychologists could say that they have a definitive answer. They do not. Nevertheless, they may be of some help with certain aspects of the problem. For the area under present discussion the major procedures available to the psychologist are psychological tests. By means of these devices he can be of aid in answering at least some of the questions that arise with regard to mental level and its disturbances. The field of psychological tests, as is generally known, has seen a tremendous development in recent years. It is a far cry from the series of situations first set up by Alfred Binet in 1904 to serve as a test of intelligence, to the approximately five thousand different kinds of tests now available. In a recent report, for instance, it was stated that a decade or so ago some sixty

million standardized tests were administered to twenty million people. Of these, some twenty-five million were given to approximately four million persons in the armed services.

What are the peculiar characteristics of psychological tests? Their purpose is to obtain systematic samples of certain types of verbal, motor and perceptual abilities and aptitudes, samples of levels of achievement, and of affective and personality characteristics, in the setting of standardized, relatively controlled situations. They have the advantage of involving little or no subjective selection in securing the data —the great source of danger involved in personal judgment. Further, the standardized scoring systems, based on standardized material, methods and norms built up from samples of the general population, permit evaluation of the data relatively free from subjective factors.

Besides the careful establishment of norms, careful training of examiners is essential to use these tests of varying degrees of complexity, accurately and with good judgment. It is further important to scrutinize carefully the examination situation in order to make sure that the conditions are such as to permit an adequate evaluation of the person under consideration. With such controls, it is possible to obtain measures with relative accuracy, the degree of this accuracy depending upon the complexity of the function tested. These measures can be compared with norms established by objective means. Psychologists can, with varying degrees of completeness and assurance, provide answers to such questions as the level of intellectual activity at which the person is functioning, the relationship that this functioning has to his presumed optimal level, and the pattern of his intellectual abilities and disabilities.

I say "with varying degrees of completeness and assurance," because of the complexity of the process of examination, as well as of the process of establishing norms. It is essential to be able to evaluate the adequacy of the examination results. Many factors play a role in arriving at a judgment as to the dependability of the results. Some of the factors which prevent results from being dependable are under the partial control of the subject: for instance, his effort, interest and self-confidence. Others are almost entirely outside the subject's control and may be of a relatively tempo-

rary kind, such as a psychotic episode, an emotional upset, some physical handicap, passing physical illness, fatigue, or poor test conditions. The psychologist is not a machine-tender, a technician who puts the subject through a machine from which an I.Q. or a mental age automatically comes out. The psychological examination is a delicate process involving the establishment of a positive relationship with the subject and the maintenance of this relationship. In fact the examiner becomes an essential part of the procedure. It therefore requires considerable skill, judgment and finesse as well as an ability to divest oneself of subjectivity. Unless examinations are carried out with care, the results are not likely to be dependable. Assuming that the conditions for examination and the competence of the examiner are satisfactory, numerous devices are available for making the evaluation of these functions in order to aid the law in its decisions. A detailed exposition of these procedures cannot be attempted here, but I might say merely that they cover almost the whole range of personality function—its emotional, as well as its intellectual aspects.

In conclusion, let me put in somewhat different words, but more succinctly, what I have been trying to say thus far. As I view the problem with my naive acquaintance of the law, in the limited area—limited to intellectual functioning insofar as such a limitation can be made—which we are here discussing, what the law wants essentially to know with regard to a person is how well he was functioning at the time when he became involved with it. The law is not interested primarily in how well he may have functioned in the past nor how well he may function ordinarily or at the height of his powers. The question the law asks is: Was he functioning above or below a certain arbitrary level of competence set by the law?

The law, in determining the level of this functioning, cannot use merely the fact of membership in a group, even a "descriptive" group. By descriptive groups I mean those in which members are classified by such characteristics as chronological age, occupation, civil status, sex, etc. We can even go further and say that neither can the law depend upon membership in "functional" groups for such determination.

By functional groups I mean those in which members are classified by such characteristics as having a psychosis or a brain lesion, or being alcoholic, or being feeble-minded. The reason I say this is because of the wide range of function to be found within descriptive groups, and the marked variation of response created by different conditions that is represented in functional groups. This range may express itself either in the total level of response or in the profile of the distribution of the functions which play a role in determining the total level. We can go further and say that even if the general level of a person's functioning becomes known to us quite accurately, we cannot depend solely on this knowledge because of the degree of variation found within the individual, created by a great variety of conditions both from within and without the person.

The implication of what I say is that the law, in this area, has primarily to take the *individual* into account. Only secondarily, may it consider the group of which he is a member. Except in certain extreme cases, because it can no longer depend on obvious descriptive classifications, the law is forced to fall back more and more upon specialists, such as psychiatrists, psychologists and social workers, to advise it about the functional group membership of the delinquent. Much more important, however, is the advice which these specialists can provide about the degree and nature of the *individual's* disturbance. The law should recognize, however, that these experts work in an area in which, at least for the present, varying degrees of certainty are attached to the evaluations that are made. It must therefore not throw overboard all those descriptive characteristics and common-sense observations which come to the legal specialist, as well as to the various psychological specialists in the psychiatric team, from day-by-day experience. I refer to that part of every one of us which is a psychologist. If care is taken to insure that the observations arising from this source are interpreted objectively and are not influenced by the personal predilections to which they are so susceptible, they may be of considerable value in providing the checks which scientific data in this field for the present not too rarely need.

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Privileged Communications*

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The claim of privilege for a communication may be made for two very different reasons. It may be asserted as a defense for what has been said or as a reason for not speaking. If, for example, one should write a letter to another containing defamatory matter in regard to a third, we have what may be libel. If we assume, for example, that the defamatory matter is false, even if innocently believed to be true, we may have the basis for either a civil action for damages or a criminal prosecution. However, if this letter was written as a confidential reply to a question asked about a person seeking employment, it was a privileged communication and, if written in good faith, this is a complete defense to any proceeding, civil or criminal.

The doctor might have occasion to rely upon this privilege but is more likely to be interested in the second. Rules of medical ethics, dating back to the time of Hippocrates at least, have sealed the doctor's lips as to professional secrets of his patients except in one regard. He is a loyal citizen as well as a physician and if the law of the land requires disclosure in some extreme situation, his duty to the individual patient is overridden by his larger duty to the Government. It may be, however, that the law itself requires nondisclosure although the truth of the matter involved is important for the decision of a case on trial. This is what is referred to herein as the "extreme privilege."

It was recognized by the common law at three points only: (1) the attorney-client relation, (2) the marital relation and (3) in regard to state secrets. The attorney-client privilege grew out of the ancient rule which did not permit an interested party to be called as a witness in any case and devel-

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oped together with the more basic privilege against compulsory self-incrimination. One must not be compelled to convict himself either by his own lips or by the lips of his counsel. The marital privilege has a similar background. It grew out of the common-law theory that man and wife were one for most legal purposes and developed under considerations of public policy to protect the privacy of the home. The reasons for nondisclosure of state secrets are obvious.

No such reason was found in the physician-patient relation. And while the privilege of confidential communications within this relation was recognized for all ordinary purposes, it did not permit nondisclosure of matters needed to be known in order that a case on trial might be decided properly.

As this extreme privilege was not recognized by the common law in the physician-patient relation, it is not found today in the common-law jurisdictions unless it has been established by express provision of statute. And unless there have been recent changes in this regard, no such statutes will be found in England, in Canada or in seventeen of our states including all of the states in New England (Alabama, Connecticut, Delaware, Florida, Georgia, Illinois, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, Rhode Island, South Carolina, Tennessee, Texas, Vermont and Virginia). Over one hundred years ago, however, New York passed a statute extending the extreme privilege to the physician-patient relation and since then thirty-one states have followed that lead, at least to the extent of some legislation in this field.

Three different patterns are found in these statutes. At one extreme is the North Carolina Act which gives the privilege in name only because it authorizes the presiding judge of a superior court to compel disclosure in any case if in his opinion this is necessary to a proper administration of justice. This makes no change in the common law other than to limit the power to the presiding judge of a superior court. Without any legislation on the subject the court would not require disclosure of such a communication unless satisfied that it was necessary to a proper decision of the case. Next in order may be mentioned those statutes which grant the privilege in civil cases only while at the other extreme are to be found those acts which grant the privilege in cases both

civil and criminal. In considering whether the privilege is limited to civil cases or extends to criminal prosecutions, it is necessary to keep in mind our dual system of government. A state statute relating to the admissibility of evidence does not apply in the federal court unless it has been adopted by the federal law. Rule 43A of the Federal Rules of Civil Procedure adopts the rules of evidence of a state in which the trial of a civil case is held except as otherwise provided by federal law. As there is no conflicting provision in the federal law, the privilege will be recognized in a federal civil case if it is granted under the statute of the state in which the case is tried. Rule 26 of the Federal Rules of Criminal Procedure, on the other hand, adopts the common law as to the privileges of witnesses except where provided otherwise by Act of Congress. As the extreme privilege was not recognized by the common law in the physician-patient relation and is not granted by any Act of Congress, it follows that it does not exist in a criminal case prosecuted in the federal court without reference to the particular state in which the court is held. In brief, this privilege exists in a civil case in almost two-thirds of the states whether the case is in a state court or in a federal court. In most of these same states it exists in a criminal case also if it is in a state court but it does not exist anywhere in a criminal case prosecuted in a federal court.

Where the privilege is recognized, it is important to have in mind to whom the privilege belongs. Who can invoke it and who can waive it? It is clearly recognized that the privilege belongs to the patient, not to the doctor. The patient can invoke it or he can waive it at his pleasure. The doctor must invoke it unless it has been waived by the patient. Differences are found in the statutes and interpretations with reference to the matter of waiver, these differences having to do largely with cases involving multiple witnesses or those arising after the death of the patient. Some of the statutes expressly provide that if the plaintiff in an action for personal injury or on an insurance policy calls any doctor as a witness, this is a waiver of the privilege as to any doctor consulted by him with reference to the same injury or disease. If the statute is silent on this subject, it is interpreted to reach the same result in some states whereas in others the patient is held to have a privilege which can be waived as to one such doctor without waiver as to any other.

It is recognized that the physician-patient privilege survives the death of the patient. Some statutes specify who has the power to waive the privilege in such a case, or those circumstances in which disclosure is permitted because deemed to be in the best interests of the deceased. Some forbid only such disclosures as might tend to disgrace the memory of the deceased patient. The interpretations of statutes silent in this regard are not in accord. The extreme position is that the privilege is too strictly personal to permit any waiver after the patient is dead except in one regard. There is little dissent from the view that a disclosure is not barred if it relates to a crime of which the deceased patient was a victim.

In criminal cases it is important to bear in mind that where this privilege has been established by statute, it has been to promote ends deemed socially desirable and not to aid in the commission of crime. Hence the privilege does not extend to a communication made in the effort to procure the commission of a crime such as an unlawful abortion or the unlawful purchase of a narcotic drug. Some statutes expressly mention this exclusion but this should not be necessary. Even the ancient and well-established attorney-client privilege will not bar disclosure of a communication made to a lawyer by one seeking advice in regard to a crime to be committed in the future.

Where this privilege has been established, it applies only to information obtained as a result of the physician-patient relation. The mere fact that a doctor sees a person who is sick or injured does not establish such a relation. It might be mere coincidence that one happened to be where he could observe the other. And if a doctor examines one person at the request of another (under court order for example) and with no thought of giving medical or surgical treatment or advice, there is no physician-patient relation between the two and the privilege does not apply. A special caution, however, is needed in this connection. If a person has been examined at the request of his lawyer, and for some purpose within the attorney-client relation, no disclosure should be made without the consent of the one examined. There is no physician-patient relation in such a case, it is true, but this examination is within the privilege of the attorney-client relation and hence is protected even in the absence of statute.

Returning to the physician-patient relation it must be added that even information coming to the doctor as a result of this relation and which aids him in his medical treatment or advice is not within the privilege if not given in confidence. A communication made to the doctor in public is not privileged and it is made "in public" within the legal interpretation of this concept if it was within the known hearing of a third person whose presence was for some purpose other than to aid the doctor in his professional work or to aid or encourage the patient. The presence of a third person who is there to aid the doctor in his professional work, or to aid and encourage the patient, does not make the statement public so as to destroy the physician-patient privilege. The doctor's lips are sealed as effectively in such a case as if the third person were not there, but the cases are not in accord as to the third person. Under the sound view his lips also should be sealed, but there is some authority to the contrary. This is particularly important in states whose statutes do not include a nurse-patient clause. The prevailing view is that even in such states the nurse must not, without the patient's consent, disclose anything she learned while assisting the doctor.

Some differences in the wording of statutes other than those mentioned above are entitled to brief attention. The wording in some, for example, is in terms of communications to a doctor by one seeking professional advice while others add also any information acquired in attending the patient. These should be held to have the same meaning because a "communication" may be made by permitted observation as well as by word of mouth. Some of the enactments include within the privilege the advice given by the doctor to the patient. This should be held to be included even if not expressly mentioned because what the doctor has learned is not kept in strict confidence if the advice given by him is disclosed. In general statutes limit the disqualification to such information as was necessary to enable the doctor to prescribe or act for the patient. This of course is not limited to the ailment which the patient knew or thought he had. The physician-patient relation includes advice in regard to ailments unsuspected by the patient but it does not include information of matters having no possible bearing upon medical or surgical treatment or advice. The fact that the examination

uncovered a concealed weapon, for example, would not be within the privilege given by such a statute. On the other hand, a question in this regard might arise under a statute such as that in Oklahoma which extends the privilege to "any knowledge obtained by a personal examination of any such patient . . ."

It is a common principle of statutory construction that if a conflict is found between a general provision and a specific provision, the latter will control. Hence reports specifically required by statute must be rendered regardless of a privilege that otherwise might be present. These vary from state to state but frequently include reports of (1) violent injury, (2) industrial injury, (3) contagious disease, (4) treating narcotic addict, (5) death certificate, (6) still-birth certificate, (7) birth certificate.

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Blood Grouping Tests in Disputed Paternity Proceedings and Filial Relationship*

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The many years of research since the discovery of the blood groups in 1900 (1) and the proof of the exact inheritance of these characters has provided a very efficient means for studying filial relationship (1, 2, 3). No other human characteristics are so secure from environmental effects as are the blood groups. Thus fingerprints may be altered, hair may grow, or be removed, the dental status can be varied, plastic surgery can change the shape of the nose, distinguishing marks can be obliterated, but the blood groups cannot be affected by age, food, disease, medicine, radiation (4), or any other known influence.** Here, therefore, is an immutable character, whose inheritance is thoroughly known, which can easily be tested in a laboratory during life and even after death as the true identification of a person!

The laboratory methods for determining the various blood groups are clear and sharp, and in the hands of qualified experts the findings are always reproducible.

The validity of these facts has been attested by the study of 20,000 families in Scandinavia and well over 30,000 families

* From the Blood Bank Laboratories of Beth Israel Hospital. This study was aided by the Joseph and Helen Yeamans Levy Foundation of Beth Israel Hospital.

** The only exception is the temporary change in the blood type that can be produced by a complete replacement transfusion, where, for a short time only, the person's original blood group may be obscured by the transfused blood. This occurs in the treatment of Erythroblastosis Fetalis (hemolytic disease of the newborn) where rh (negative) blood is used to replace the infant's Rh (positive) blood as completely as possible. Within a few weeks the infant's original blood group reappears.

in the United States. In this vast research study only a single exception to the expected results not due to illegitimacy or error has been demonstrated, and that exception was a child with a multiplicity of congenital defects resulting from a severe mutation in genetic development. The essential accuracy of the theory of inheritance of the blood groups, as well as the reliability of the technic of blood group determination, is thus attested.

In the United States, due to the energetic efforts of both lawyers and serologists, the courts in many states have recognized the infallibility of blood testing and have passed legislation to this effect. Thus, New York, Wisconsin, Ohio, Massachusetts, New Jersey, South Dakota, Maryland, North Carolina, Pennsylvania, and Rhode Island (5) have statutes authorizing blood tests in disputed paternity proceedings. In the other states, if the parties mutually consent, the test can be ordered and the results, if conclusive, can be offered in evidence. Blood testing, it must be understood, is of value only in a negative way, that is, the expert can only state that the test excludes paternity or that the blood stain is not that of the suspect. The positive identification of a person by means of blood testing is a goal for the future, as it is believed that the complete blood group of a person is more individual than even his fingerprint. In addition the results obtained by blood grouping are *noncontroversial* as the findings reported are those observed and are not subject to varying experts' opinions. The infallibility of the tests is accepted providing certain safe-guards are maintained. These are:

1. The serologist must be a qualified expert. These qualifications have been agreed upon by a panel of experts and are listed in a pamphlet prepared for the American Medical Association. (6)
2. The parties must be satisfactorily identified. Signatures, fingerprinting and mutual identification are suggested. Specimens must be clearly marked.
3. The blood tests must include *all* medico-legally recognized groupings.
4. The blood tests must be carefully and competently performed.
5. The sera used must be potent and controlled.
6. The results must be checked and confirmed.

The Federal Courts, governed by the rules of evidence of the State in which the trial is held, have likewise accepted the evidence offered by blood tests in those cases where the results are pertinent.

The type of legal cases in which blood tests are used is steadily increasing as their value is brought to the attention of the profession. To date, these include:

1. Paternity proceedings, disputed and otherwise.
2. Divorce and annulment actions in which paternity is a factor.
3. Rare "exchanged" baby cases.
4. Derivative citizenship and claims of paternity.
5. Personal identification.
6. Examination of blood stains, sputum, semen and other body secretions to determine blood groups when possible.

The number of blood factors known to serologists and for which testing serums are available is increasing steadily. Originally only the A-B-O system involving 4 varieties of blood was described. Over the years new blood systems and further differentiations within each system have increased the number of combinations of blood factors until at present approximately 100,000 serologically different individuals can be identified by their blood groupings.

Medico-legally, blood grouping at present is limited to the A-B-O, M-N, and Rh-Hr (6) systems only. Actually 13 well-recognized systems are known but the unavailability of testing serums, the difficulties with the technics, and insufficient statistical experience limit their usefulness in all but research laboratories. In actual forensic work, using the 3 available acceptable systems, there are 216 varieties of blood demonstrable. By mathematical formula Wiener (7) has calculated the possibility of exclusion by each system as follows:

A-B-O—18% chance of exclusion.
M-N —20% chance of exclusion.
Rh-Hr—25% chance of exclusion.

Thus the chance of exclusion of a falsely accused man by the combined use of all three systems is over 50%.* As more

* The possibility of exclusion by the use of all three systems is not their sum, because of the possibility of exclusion by more than one system. The total chance of exclusion (from Wiener) is derived from the formula:

systems are accepted by the Committee on Medico-legal Application of Blood Grouping Tests (6), this figure will increase.

The theory relating to the inheritance of the blood factors can be summarized in one sentence: "A blood factor cannot appear in the blood of a child unless present in the blood of either parent." The practical application of this law of inheritance can be clarified by the following rules:

1. The blood properties A, B, M, N, Rh_0, rh′, rh″, hr′, and hr″ cannot appear in the blood of a person unless they are present in the blood of one or both his parents.
2. A parent who is of group AB cannot have a child of group O, and a parent of group O cannot have a child of group AB.
3. A parent of group M cannot have a child of group N, and a parent of group N cannot have a child of group M.
4. A parent who is rh′ negative cannot have a child who is hr′ negative and a parent who is hr′ negative cannot have a child who is rh′ negative.
5. A parent who is rh″ negative cannot have a child who is hr″ negative. A parent who is hr″ negative cannot have a child who is rh″ negative. (This latter law is subject to some qualification in view of recently reported exceptions in Negroids by Wiener. (7))

300 successive cases involving disputed paternity proceedings were studied during the past three years (1952–1955) in New York City. 43 accused men (14%) were excluded by blood tests. Since the probability of excluding a falsely accused man by blood testing is approximately 50%, it is obvious that this group of 300 includes another 43 falsely accused men (14%) who could not be excluded by blood testing. To this total figure of 28% must be added 26 cases or 9% where the woman refused to appear for the blood test, a circumstance which must be viewed with suspicion. Thus a total figure of 37%, therefore, probably represents the number of cases involving paternity disputes where the man has been falsely accused! To repeat, approximately 4 out of 10 men who were defendants in paternity actions in New York City were falsely accused. The following table lists the blood groupings in the 43 cases and the blood group system involved in the exclusion: (8)

$P = 1-(1-P_1)(1-P_2)(1-P_3)$ etc. where P_1, P_2, P_3 represent the chance of exclusion in each system.

Table 1

300 Successive Disputed Paternity Cases with 43 Exclusions Using A-B-O, M-N, and Rh-Hr Systems

No.	Putative Father	Mother	Children	Excluded by System
1	O N Rh_2rh	O MN Rh_o	a) O N Rh_2rh	Not excluded
			b) A_1 MN Rh_o	A-B-O
2	A_2B MN Rh_1rh	B MN Rh_o	a) O M Rh_o	A-B-O
			b) B N Rh_o	Not excluded
3	O MN Rh_2rh	O MN Rh_2rh	A_2 MN Rh_2rh	A-B-O
4	O MN Rh_1rh	O M Rh_2Rh_o	A M Rh_2Rh_o	A-B-O
5	A N Rh_2rh	A M Rh_2rh	B MN Rh_2rh	A-B-O
6	B MN Rh_2Rh_o	B M Rh_1rh	A_1 MN rh	A-B-O
7	B M Rh_2rh	O MN Rh_o	a) A_1 M Rh_o *	A-B-O
			b) O M Rh_o *	Not excluded
8	O MN Rh_o	B MN Rh_o	A_1 MN rh	A-B-O
9	A_1 M Rh_1Rh_1	A_1 MN Rh_1rh	A_1B M Rh_1rh	A-B-O
10	A_1B M Rh_1rh	A_1 MN Rh_1rh	O M Rh_1rh	A-B-O
11	A_1 N Rh_1rh	O MN Rh_2rh	a) B N Rh_o	A-B-O
			b) A_1 N Rh_2rh	Not excluded
12	A_1 MN Rh_1Rh_1	A_1B MN Rh_2Rh_o	a) A_1 N Rh_1Rh_1	Not excluded
			b) O N Rh_2Rh_o	A-B-O
13	A_1 N Rh_1rh	O M Rh_2Rh_o	a) O M Rh_1Rh_1	M-N
			b) A_1 MN Rh_1Rh_1	Not excluded
			c) O M Rh_2rh *	M-N
			d) A_1 MN Rh_2rh *	Not excluded
14	B N Rh_o	A_1 M Rh_o	A_1 M Rh_o	M-N
15	O N Rh_1rh	A_1 M Rh_2rh	a) O M Rh_2rh	M-N
			b) A_1 M Rh_2rh	M-N
16	A_1 N Rh_2Rh_o	A_1 N Rh_1rh	A_1 MN Rh_1rh	M-N
17	O N Rh_2Rh_2	A_1 MN rh	O MN Rh_1rh	Rh-Hr
18	B MN Rh_o	A_1 N Rh_1rh	a) A_1 N Rh_o	Not excluded

					b)	A_1	MN	Rh_2Rh_0	Rh-Hr
19	A	MN	Rh_0	B	M	Rh_2Rh_2	B	MN	Rh_2Rh_0	Rh-Hr
20	B	MN	Rh_1Rh_1	B	N	Rh_1Rh_1	B	MN	Rh1rh	Rh-Hr
21	O	M	Rh_0	O	MN	Rh_0	a)	O	MN	Rh1rh	Rh-Hr
							b)	O	M	Rh_0	Not excluded
22	A	N	Rh_2Rh_2	O	M	Rh1rh		O	MN	rh	Rh-Hr
23	O	MN	Rh_1Rh_1	A_1	MN	Rh_2Rh_2		A_1	N	Rh_2Rh_2	Rh-Hr
24	B	M	Rh1rh	A_2	MN	Rh_1Rh_1		O	MN	Rh_2Rh_0	Rh-Hr
25	A_2	MN	Rh_1Rh_1	A_1	M	Rh1rh		O	MN	rh	Rh-Hr
26	A_1	MN	Rh_0	O	MN	Rh1rh		O	MN	Rh_1Rh_1	Rh-Hr
27	A_1	MN	rh	A_1	N	Rh_1Rh_1		O	N	Rh_2Rh_0	Rh-Hr
28	B	MN	Rh_0	B	M	Rh_0	a)	B	MN	Rh1rh	Rh-Hr
							b)	B	M	Rh_0	Not excluded
29	B	N	Rh_0	O	N	Rh_0		O	N	Rh1rh	Rh-Hr
30	O	MN	Rh_0	B	MN	Rh_0		B	N	Rh1rh	Rh-Hr
31	B	M	Rh_0	B	M	Rh_0		O	M	Rh1rh	Rh-Hr
32	A_1	M	Rh1rh	O	N	Rh2rh		B	N	Rh2rh	A-B-O, M-N
33	O	M	Rh_2Rh_0	A	M	Rh1rh		A_1B	MN	Rh_1Rh_1	A-B-O, M-N
34	A_1	N	Rh1rh	O	M	rh		B	M	Rh_0	A-B-O, M-N
35	A_1	M	Rh1rh	O	MN	Rh_2Rh_0	a)	A_1	MN	Rh1rh	Not excluded
							b)	B	MN	Rh2Rh2	A-B-O, Rh-Hr
36	O	M	Rh2rh	B	M	Rh2rh		A_2B	M	Rh1rh	A-B-O, Rh-Hr
37	O	MN	Rh_0	O	MN	Rh1rh	a)	O	MN	Rh1rh	Not excluded
							b)	A_1	M	Rh_1Rh_1	A-B-O, Rh-Hr
38	A_1	MN	Rh_1Rh_1	O	M	Rh_2Rh_2		B	M	Rh_2Rh_2	A-B-O, Rh-Hr
39	O	M	Rh2rh	A_1	MN	Rh_0		A_1	N	Rh_2Rh_0	M-N , Rh-Hr
40	B	N	Rh_1Rh_1	A_1	M	Rh1rh		A	M	Rh_2Rh_0	M-N , Rh-Hr
41	A_2	M	Rh_1Rh_1	O	M	Rh_1Rh_1		O	MN	Rh1rh	M-N , Rh-Hr
42	O	M	Rh_0	O	M	Rh1rh		O	MN	Rh_1Rh_1	M-N , Rh-Hr
43	B	N	Rh_1Rh_1	O	MN	Rh_1Rh_1	a)	O	N	Rh_1Rh_1	Not excluded
							b)	A_1	M	Rh_2Rh_0	Triple: A-B-O, M-N , Rh-Hr

*Twins

A summary of the blood group systems in which these exclusions were obtained is listed in Table 2.

Table 2

Exclusions Obtained by Systems	
A-B-O:	12
M - N:	4
Rh - Hr:	15
A-B-O and M-N:	3
A-B-O and Rh-Hr:	4
Rh-Hr and M-N:	4
A-B-O, M-N, and Rh- Hr:	1

It is easily understood why the blood grouping tests must include all three of the acceptable systems, especially the subgroups of the Rh-Hr system. Thus, 15 (35%) of the 43 exclusions were revealed by study of the Rh-Hr subgroups alone, and would not have been found if the tests were limited to the A-B-O and M-N systems only. Complete study of every available blood system should be carried out in order to consider the tests adequately performed. It is hoped that within a short time the S-s and K-k (Kell) systems will be acceptable and available for paternity studies.

The following cases are presented for their unusual interest:

1. Cases involving twins:

Father	Mother	Children	Excluded by System
a) A_1 N Rh_1rh	O M Rh_2Rh_o	a) A_1 MN Rh_2rh	Not excluded
		b) O M Rh_2rh	M - N
b) B M Rh_2rh	O MN Rh_o	a) A_1 MN Rh_o	A-B-O
		b) O M Rh_o	Not excluded

In these two cases involving dissimilar twins the question of dual paternity was raised. While biologically possible, such

findings have not been reported in man, although there are reports of this in animals. In these cases the judicial ruling excluded the accused man of being the father of either child.

2. Paternity dispute involving 10 children. The putative father in this case was a man of 60 who readily admitted maintaining two households. With his legally wedded wife he had 4 children. In addition, in his extramarital household, he maintained a second family consisting of a mother and a total of 10 children whose ages varied from 1 to 17 years. His reason for suddenly raising the question of paternity of the children was his denial of any relationship with their mother for a period of 3 years, whereas the youngest child was only 1 year of age. The results of the blood grouping were as follows:

Putative Father	Mother	Children	
A_1 MN Rh_1Rh_1	O M Rh_1rh	Age 17	O MN Rh_1Rh_1
		15	A_1MN Rh_1rh
		14	A_1MN Rh_1rh
		13	A_1M Rh_1Rh_1
		11	A_1M Rh_1Rh_1
		9	A_1MN Rh_1rh
		6	A_1MN Rh_1rh
		4	A_1M Rh_1Rh_1
		3	A_1MN Rh_1rh
		1	A_1M Rh_1rh

Such an impressive similarity in blood types speaks strongly for a common father, except for the oldest son, who represents the only group O child amongst the ten. The probability of the accused being the father of all but the first child is obviously extremely great. However, blood grouping is only capable of excluding paternity, and in this case, of course exclusion was not possible.

3. Exclusion of Maternity:

Male	Mother	Children	Excluded by System
A_1 MN Rh_1Rh_1	A_1B MN Rh_2Rh_o	a) A_1 N Rh_1Rh_1	Not excluded
		b) O N Rh_2Rh_o	A-B-O

In this surprising case the second child was found to be of group O, whereas the "mother" was group AB. As this mother could only transmit to her offspring an A or a B gene, it is impossible for her to have a child of group O (lacking either A or B). This woman honestly believed the child was her own. Careful review of her past history indicated that she had been separated from the child for several years immediately after delivery. The possibility of a substitution thus existed.

Chinese Immigration and Blood Tests

Another interesting use of blood grouping in matters concerning paternity was demonstrated by Schatkin, Sussman, and Yarbrough, in the New York Law Journal (9) and the Criminal Law Review (10). Here a problem of Chinese Immigration presented itself to the United States Immigration and Naturalization Service. Applications for derivative citizenship had flooded the service in recent years. The circumstances exposed were such as to arouse considerable suspicion in the minds of the investigators. These consisted of:

1. Each visit to China resulted in a crop of sons only, no females were reported as being born.
2. No records of births were available.
3. Separate interrogation of father and applicant sons showed evidence of collusion in the similarity of detailed testimony.

The discovery of "coaching books" indicated a brokerage system behind the scenes. However it was the introduction of blood testing that finally exposed the fraudulent nature of the operation. Blood testing demonstrated that 40% of the applicants could *not* be the sons of the alleged fathers. Actually the limitations of exclusions obtained by blood testing are such that only one-half of the false claims can be exposed. It is therefore clear that double the number of exposed false claims or 80% were truly false. This evidence of a fraudulent operation on a tremendous scale was of great help to the Immigra-

tion and Naturalization Service in processing applications for derivative citizenship.

Conclusion

1. 300 cases of disputed paternity proceedings are presented, in which blood testing excluded 43 or 14% of the defendants.
2. The total number of men probably falsely accused in this series of 300 cases is shown to be approximately 111 or 37%.
3. The value of blood testing in personal identification, disputed paternity actions and other claims of filial relationship is demonstrated.
4. Blood testing is an important and valuable medico-legal procedure and should not be neglected in any pertinent situation.

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Education and Qualifications of Examiners of Questioned Documents*

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The examination of questioned documents applies scientific methods in order to determine facts concerning the authenticity and preparation of documents. These methods have been developed over a period of years and for many problems have become standardized. To be employed properly, however, requires a highly competent and specially educated document examiner. This paper will consider his professional qualifications. How does one become an examiner of questioned documents? What is his background, training, and experience?

What Is a Document Examiner's Background?

The background or pre-professional training of document examiners is almost as varied as their individual personalities. This generalization is not entirely true. Many of the older workers—the pioneers in the field—had been trained to teach penmanship. This background was very appropriate. It gave them a clear insight into the individuality of handwriting and the difficulties encountered by learners and those who attempted to change or improve their writing. In those days the great bulk of the problems which came to their attention involved the identification of handwriting and the detection of forgery. Today these problems represent a large proportion of the work, and consequently, training, experience, or a detailed knowledge of handwriting instruction is still a useful background.

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Over the period of years there has been a general expansion in the scope of work undertaken by the document examiner. Many of these newer problems involve the application of chemistry and physics. All require a full appreciation of scientific methods and a scientific state of mind. Thus, certain of the younger men—the present generation of document examiners—hold university degrees with specialization in fields of science.

These two groups do not exhaust the general background of men examining documents today. A few professional photographers, having first become acquainted with questioned document problems through specialized photography, have with study become qualified document examiners. Likewise, certain lawyers have followed this newer profession.

With these varied backgrounds, what are the most desirable attributes for one entering this field? Education or experience which develops a scientific attitude is of direct value. So are special skills such as knowledge of handwriting instruction, photography, chemistry, and the like. Formal legal training may be of help, but if it has gone so far as to develop a spirit of advocacy, it can be a hindrance. The document examiner's basic task is to determine facts in documents. His background and temperament should equip him to accomplish this task objectively.

Professional Training

Regardless of what basic education and skills a document examiner may have, it is absolutely essential that his professional training be thorough and complete. It should definitely cover such distinctive phases as handwriting, typewriting, and ink identifications, decipherments of erasures, detection of alterations, specialized photography, and the fundamentals of paper identification.

One of the most important subjects, and probably the most difficult to master completely, is the principle of handwriting identification and its application to actual case work. The student must fully appreciate the peculiarities of each problem resulting from the individuality of writing and the personal equation of natural variation. The possibility of forgery further complicates some problems. Writing is a personal act. The human equation plays a significant role. Writing posi-

tion, instruments used, the writer's physical condition, and even his state of mind must be reckoned with. The written strokes can reflect these and other influences. Thus, the identification of handwriting and the detection of forgery is not a mechanical process, but involves knowledge of the basic principles, keen observation of detail, and scientific reasoning tempered with experience.

Typewriting identification makes up the second group of problems with which he will be frequently confronted. In order to identify typewriting accurately, he not only must learn what factors individualize a machine, but also how typewriters develop these defects or peculiarities. The historical development of machines and type faces is essential information in this work. He must have knowledge of how typewriters are built, and especially the steps in the manufacturing process which have a bearing on identification problems. His training should include visits to typewriter factories and to repair shops. All of this work must of course be combined with detailed examinations necessary for actual machine identifications.

The detection and decipherment of erasures and alterations depends upon intelligent application of microscopy, chemistry, and physics. The document examiner must correctly recognize what he sees under the microscope. What at first glance to the uninitiated seems obvious is not always the fact. The application of chemical methods to erasure problems calls for special training, while infrared and ultraviolet examinations are far from automatic. Special photographic techniques round out the fundamentals necessary for these problems.

The identification and differentiation of inks and papers are accomplished through the use of the same basic sciences and scientific aids—chemistry and physics, microscopy and photography. Micro- and semi-microchemical identifications are important. Furthermore, knowledge of the manufacturing processes and how they affect and limit what can be determined from technical examinations must supplement the laboratory instruction.

Finally, his training must include thorough grounding in photography. The document examiner should be qualified to handle all phases of photography connected with his work.

Besides the routine copying of documents, special photographic methods must be mastered.

These classes of problems will constitute the bulk of his work, but numerous other questions arise for which he should have some preliminary training. They include, for example, writing carefully covered over or obscured with ink, damaged documents, charred papers, identification of printed material, and examination of check writers.

Obviously, professional training must cover a broad field. Some phases of the studies may not at first appear too closely related, but as the student continues, he will come to realize the inter-relationship of all questioned document problems. His training must tell him not only how to do the job, but also give him a full appreciation of the importance of considering a document as a whole in every problem that is brought before him.

Finally, after the beginner has mastered the fundamentals he must also learn the art of testimony and how to present cases in court. His technical training is of course the most important phase, but in order to prevent findings against the facts in court, he must be able to translate his conclusions into clear, forceful testimony.

Instruction Methods

Examiners of questioned documents are for the most part self-educated in their field of professional specialty. Some of these have augmented this personal study by a period of apprenticeship or training under the supervision of a more experienced man. There are no formal courses. No university program has been developed to educate questioned document examiners like chemists, doctors, and other professional workers.

There are three possible methods for instruction of a student document examiner—apprenticeship, university study, and self-education. All three are not readily available today, but it is worthwhile to analyze their potential values. Each has some aspects to recommend it and some obvious defects.

Apprenticeship. An apprenticeship training is one of the oldest educational procedures. With this program, a student or trainee works under close supervision of one whose knowledge and ability is clearly established. There is much to recommend this method for training a questioned document

examiner. The trainee is able to handle problems which arise from day to day and to supplement all of his basic reading and instruction with practical laboratory experience. His methods and findings can be constantly checked and rechecked so that he does not go astray and arrive at conclusions inconsistent with the facts.

The basic disadvantage is that the training really is only as good as the master. In the field of questioned document examination where there is no concrete measure of competency, there is bound to be those of great and those of very little ability. Consequently, some instructor's ability may be so limited that the whole procedure is much like the blind trying to lead the blind. Even among the more competent there are differences in teaching skill. A novice wishing to arrange for an apprenticeship has no way of determining the professional and teaching ability of available instructors.

Nevertheless, a general evaluation establishes this method of training as the best now available. Other programs have far greater defects and limitations, and one seriously wanting to undertake this work should seek at least a year of instruction under the supervision of a competent man.

University Training. In this country we have come to recognize the universities as a source of training for all professions and many specialized types of business and artistic endeavors. Schools within the university have been set up to teach law, medicine, dentistry, commerce, music, and the like. In many respects a questioned document examiner warrants the same thorough training as an attorney. Unfortunately, the opportunities and need for document examination are greatly limited, and consequently there is not sufficient demand to warrant establishment of a special school within a university or a field of major study within a department such as police science. The only university programs now available consist primarily of courses which survey the more common document problems, and discuss in general how they are solved.

The basic advantage of a university program would be greater standardization of instruction than under the present apprenticeship training. But this would only come about in the course of years as the curriculum was adjusted to turn out the most competent graduates.

A one-year advanced university course would at best be rather superficial preparation. Twenty semester hours during two semesters (nine months of school) should lead to a basic background but could not possibly develop the student to the point that he would be able to handle case work competently. When this program of study is compared with a year's apprenticeship involving at least a forty-hour-week training program supplemented with outside reading and study, its deficiencies are at once apparent.

A university might have further difficulty in procuring competent instructors who properly could handle the student training. With the limited number of men in this profession, their services, and especially the more competent, are in steady demand. Thus, when all factors are considered a university training program could be of assistance, but it presents many difficult problems which must be resolved.

Self-education. Self-education of the document examiner is a form of study which the progressive workers must continually turn to. Document examination is a field of work in which one who does not study cannot keep up to date. Just the periodic changes in typewriters, check writers, pens, pencils, and paper require that one must constantly be alert to changes which affect an identification.

Some very competent men have reached their present state of proficiency almost entirely through self-training. There are several well-written, comprehensive texts which, when intelligently read and studied, prepare one to examine documents correctly and to carry out various chemical and photographic tests. This method of learning the fundamentals, however, is undoubtedly the most arduous.

For a number of men this is the only way open. Until they have achieved some degree of competency, and demonstrated high ethics, they may find it difficult to consult with and to benefit from the ideas of other practitioners. Some independent document examiners hesitate for a long time before they offer advice and help; in general, government laboratories are closed, as far as study is concerned, to those outside that branch of the government. Physical location of an office in a smaller city in which there are no other men doing this work, generally means that contacts with other document examiners

are at best infrequent. Consequently, a number of beginners must depend solely on their own resources.

While individual study can lead to competency, there is always a danger, and a very serious one, that a novice working and studying alone will get off the accepted track, hit upon methods which do not lead to accurate findings, and continue to repeat the same errors over and over. Unless these faults can be corrected early, he is apt to believe that his procedures are superior and, despite later consultation and education, will not abandon them. Here is the most serious weakness of self-education.

The Basis of Court Qualification

With the diversity of training and the lack of standardized education, how can the courts properly determine whether the document examiner is qualified? Actually, such qualification should be based entirely upon ability to do the work and to reach the correct conclusion. Courts cannot test the expert witness in this way. They must depend instead upon such factors as the number of years and extent of experience, general and special education, appearances in other courts, general reputation, writings, lectures, membership in professional organizations, and other professional recognitions which might have been accorded the witness. These criteria do give some indication of a man's ability, but there is a tendency to overemphasize the number of years experience and the number of court appearances. Unfortunately, there are some who have testified time and time again, year after year, and still fail to reach the right conclusion with regularity.

The only way to improve the courts' ability in judging a document examiner's proficiency is standardization of his basic training. With a relatively small profession, it is difficult to establish proper standards of training and qualifications. Nevertheless, the problem should be faced by all document examiners and all professional societies interested in this phase of scientific evidence.

Conclusions

To a large degree all document examiners are "self-made experts." Personal study and research is the chief way to

keep abreast with new problems. With a number of beginners, this is the only course. Furthermore, at the present time there is no examining board which could test and certify that a man is competent. There is a great need today for standardization of training and a need for a universal testing procedure whereby all who are to practice either as a private consultant or as a public servant can be tested for their competency. The unfit must be weeded out. The basic problem is to establish the standards and to choose those who will do the weeding.

Summary

We have outlined the professional qualifications of an examiner of questioned documents—how one becomes a document examiner. What is his background, training, and experience.

The varied background or pre-professional training of men in this field is discussed. It includes early training in penmanship instruction, education in the field of the natural sciences, photography, and law. Essentials of the professional training of a document examiner outlining its scope and its various phases are reviewed.

Consideration is given to the three possible methods of instruction: apprenticeship, university training, and self-education. Finally, the factors which make up the professional qualifications of a document examiner in the eyes of a court are cited, and the crying need for a standardized program of training and a universal testing procedure is pointed out.

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Annual Meeting *American Academy of Forensic Sciences*

Drake Hotel, Chicago, Illinois, February 28 March 1–2, 1957

General Sessions—Section Meetings

Pathology—Toxicology—Immunology—Psychiatry—Law—
Questioned Documents—Police Sciences.

Distance Determinations in Cases of Gunshot Through Glass*

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Recently our laboratory was requested to assist in the investigation of a murder case that occurred in one of the Gulf Coast cities. The circumstances of the case were as follows: The victim was found dead of a bullet wound in the doorway of the middle room of his three-room house. The house was the type generally referred to as a "shotgun house," that is, all of the rooms are in a straight line with connecting doors. The front door of the house and the door connecting the first and second rooms were approximately in a line. The house and yard were enclosed by a fence approximately fifteen feet from the sides of the house. The officers, in their investigation, had found the front door and the second door open and what appeared to be a bullet hole in one of the windows of the center room. In his statement, the defendant said that he had returned the victim's fire from the front of the house and at no time did he cross the victim's fence and enter the yard. It appeared to the officers that the fatal bullet had penetrated the window from the outside, and that if the defendant had crossed the fence he would have been within range for powder particles to have been deposited on the glass. They therefore requested any assistance that we might render in establishing the muzzle distance of the defendant's gun.

From a search of the literature, we were unable to find any account of methods or techniques that might be used in examining powder residues on window glass. We felt that the

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most adaptable method for such an examination would be along the lines of the methods described by Walker (1, 2) in the examination of gunpowder residues on clothing. We used twelve-inch-width adhesive tape cut in lengths sufficient to cover the residue areas on the glass and pressed all areas of the tape firmly against the glass. By touch, we could determine the outlines of the bullet hole and drew it on the back side of the tape by pencil. The tape was removed from the glass and placed over a folded towel, adhesive side up. A piece of cloth, previously treated with 0.5% sulfanilic acid solution and 0.5% alpha-naphthylamine in methyl alcohol, was placed over the tape. A cloth moistened with 25% acetic acid was placed over this and then pressed with a warm iron. On removal of the pressing cloth, the positions of the powder particles on the tape were seen as red dye-spots on the treated cloth. Using transmitted light, the outline of the bullet hole was transferred from the tape to the cloth. We found that the dye-spots faded rather rapidly and suggested the use of color or black and white photography to establish a permanent record of the position of the powder particles. The use of photography is especially recommended where there are numerous powder particles as in a pattern at close range. At distances where the powder particles are not so numerous, a wax pencil was used to indicate the powder particle position. The tape and cloth were then washed in water followed by methyl alcohol, and dried.

In the case cited, a darkened area was noted around the bullet hole which could be used together with the nitrite deposits to approximate the gun muzzle distance. The gun was established as being fired at a distance less than one foot from the window, thus placing the defendant within the fenced enclosure and giving a clearer picture of the true facts in the case.

Our experience has indicated that this character of case happens infrequently; however, the technique employed raised many interesting questions, and it was decided to continue the study in an effort to determine more definitely the variables which might be encountered and the degree of accuracy which might be expected.

In the course of our testing, we found that the patterns obtained from clean glass were consistent with patterns obtained from firing into target cloths and using treated photographic paper to obtain the powder pattern. The patterns obtained from extremely dusty and dirty glass were less consistent with the patterns obtained from target cloths using treated photo paper. It was felt that probably vibration of the glass as a result of the penetration of the bullet may have dislodged powder particles along with the underlying dust and dirt. As in the application of this technique in the examination of clothing, there must be a careful control of conditions under which standard or test shots are fired. In instances involving dusty and dirty glass, conclusions drawn, or opinions expressed, must be in accord with the known limitations.

Another technique was used in which the glass was sprayed, by means of an atomizer, with 25% acetic acid and then pressed against treated photo paper. The paper was brought into close contact with the surface of the glass by using a rubber roller or a warm iron. Results using this technique were not satisfactory and do not justify its use.

Another laboratory aid in connection with the determination of the powder pattern on clothing is the use of photographic paper ruled in one-inch squares. This may be prepared by exposing the paper to a ruled negative before developing, fixing, washing and drying. The paper is ready then for use in the same manner as with plain desensitized paper.

Conclusion

Limited study indicates that satisfactory distance determinations can be made in instances where firearms have been discharged through glass within the usual range of the deposit of nitrite particles by the firearm in question. More accurate determinations are possible in cases involving clean window glass than in dusty or weather-stained glass. Patterns are best prepared by transfer to adhesive tape prior to processing as contrasted to direct transfer to desensitized and treated photographic paper.

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Methods of Investigation in the Identification of Human Remains*

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One of the problems not infrequently encountered by the forensic pathologist is the identification of human remains and, concomitantly, establishing the cause and manner of death.

These human remains are presented to the pathologist with the all too common story of having been found by some innocent passer-by or hunter in a remote part of the city or county. The pathologist has nothing to start with but the remains brought to him and he must then attempt to identify the remains by the application of various medical and nonmedical methods of investigation.

It can be seen that the problem differs from the identification of remains found following major conflagrations, aircraft disasters and other catastrophes where there is usually some means of ascertaining from relatives, passenger lists or other sources the identity of the individuals involved. The matching of the remains with the descriptions is usually fairly easily accomplished and has been well documented in the literature.

To achieve his purpose the forensic pathologist must have at least a working knowledge of many medical specialties such as anatomy, radiology, anthropology and dentistry as well as a knowledge of what information can be learned from the nonmedical evidence presented with the remains. The forensic pathologist must utilize every piece of evidence, no matter how inconsequential it seems at the time, and he cannot limit himself strictly to an examination of the body or the remains. In many cases, unless the pathologist himself recognizes the significance of certain evidence before him and fol-

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lows it up, no other investigative agency is available or interested enough to aid him. Cordial relations with the local police department are, of course, essential to the success of any forensic pathologist.

In many sections of the country it is impossible to have specialists in these allied fields available at all times. Even where they are available there may be financial difficulties involved in obtaining their services or their experience may be of no great assistance in the particular problem since their work is usually presented to them in a somewhat different form from that which comes to the pathologist.

The pathologist must become his own expert by being versed in the fundamentals of these fields, having available the textbooks and literature of these specialties as well as the various charts and tables used to estimate age, sex, height, race and other factors useful in identification work. He should know the various systems of numbering teeth, how dentists describe teeth, and he should know at least some of the dental conditions that might lead to confusion in counting teeth such as the rotation and migration of a second molar anteriorly to fill the space left by the extraction of the first molar, resulting in the impression that the second molar is the tooth that is absent.

In all cases of identification of human remains a positive identification is simple once the material is brought to the proper person who can make the identification. That is to say, a dentist may positively identify a person from dental records, or, a conclusive identification may be made when x-rays of a person taken during life match exactly the bony changes found in a skeleton. The real problem, however, is to arrive at that stage of the procedure where the final comparison can be made. It is obvious that the most detailed examination of the material is of no value unless the forensic pathologist knows what to do with that information.

I will present four cases from our files to illustrate the application of some of these principles.

Case I. Late one April evening a young couple found a skeleton in some underbrush of a ravine parallel to a railroad track. The remains had been there for some time and portions had been carried away by animals. The bones, clothing and surrounding debris were brought to our laboratory, and

Figure 1 shows the bones as they were finally sorted out. It was noted that the bones of the right side of the body, including the skull, showed multiple fractures. This pointed to an extensive blunt-force injury. The finding of the body beside a railroad made it a presumptive deduction that death had occurred from being struck by the train or from falling from the train.

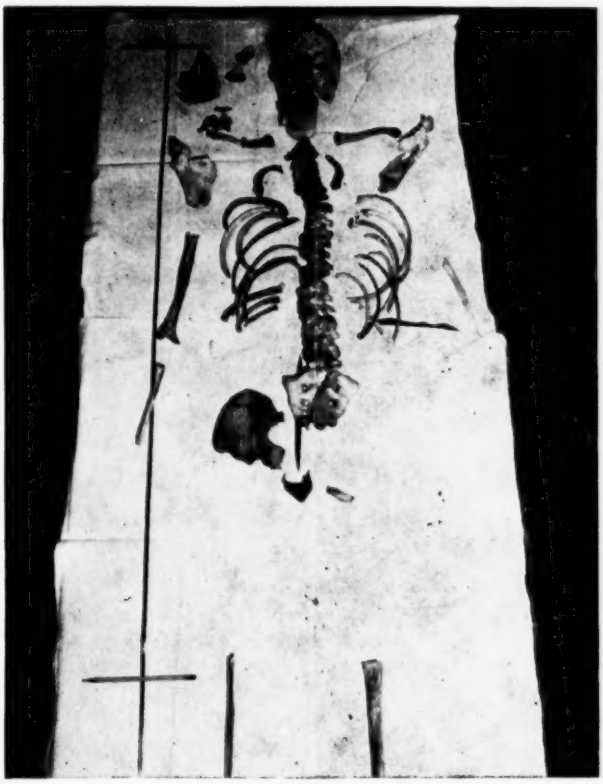

Fig. 1—Skeletal remains found in ravine beside railroad track.

The sex was determined from examination of the skull and available portions of the pelvis which were identifiable as female. A vaginal tampon found in the remains was also suggestive of the female sex as were the skirt, blouse, brassiere and feminine oxford shoes, although we do not rely on such tenuous evidence as clothing alone in establishing sex.

Measurements of the long bones gave an estimated height of 64 to 66 inches. The skull measurements and features were characteristic of the Caucasian race. Estimation of age between 18 and 30 years, more likely between 20 and 25, was based on examination of skull suture line, the teeth, and the anatomical characteristics of the bones. The third molars were erupted and there was minimal erosion of the occlusal surfaces of the teeth (Fig. 2). The sagittal and coronal suture lines showed evidence of early endocranial closure.

Fig. 2—Teeth showing dental work.

From medical procedures it was established that the decedent was a white female of between 20 to 25 years of age,

about 64 to 66 inches in height and of medium to heavy build, whose death was in some way associated with a train.

Nonmedical procedures were then employed to complete the identification. Examination of a package of cigarettes found in the clothing revealed the manufacturer's code symbols (Fig. 3). These code symbols are placed on the internal

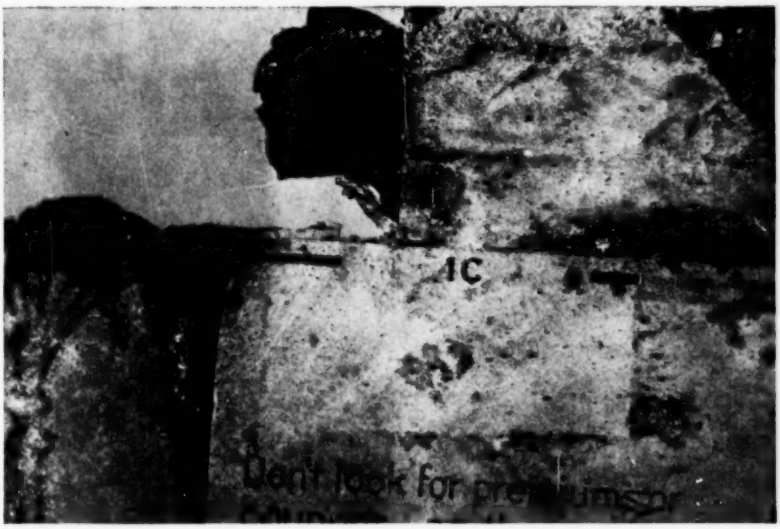

Fig. 3—Cigarette package found with skeletal remains showing code symbols of manufacturer.

revenue tax stamp on the package to indicate the date of shipment of a given lot of cigarettes, and the area to which the shipment is made. The manufacturer can also supply information regarding the length of time a shipment of cigarettes will last in a particular area. Figure 4 shows some of the common brands of cigarettes and the code symbols of the manufacturer.

In the present case we learned that this package of cigarettes had been distributed in the general area where the skeleton was found around the first of August, and, that in that particular area, the shipment was sold out in six to eight weeks. This furnished the working hypothesis that death had occurred sometime in August or September and was really the most reliable evidence we had of the time of death since

the bones were almost completely devoid of soft tissue and were unreliable in estimating the time of death.

Fig. 4—Common brands of cigarettes showing various code symbols.

There was a contrast between the clothing which was cheap and of poor quality, and the dental work which was of high quality. The natural assumption was that the dental work had been done in some dental clinic.

A state mental institution near the site of death was contacted but none of their inmates listed as missing fitted our description. All of the state newspapers then printed a description of our findings. Out of all the missing persons subsequently reported to us one sounded promising. The family said the daughter's dental work had been done through the City Welfare Department several years before. A check of the records produced the name of the dentist who had done

the Department's dental work at that time. The skull was shown to the dentist and he made positive identification from his dental record of treatment of this girl.

The girl's family also told us she had been an inmate of the state institution previously contacted. This time the institution was called and told that this girl was missing. Upon further investigation the officials found that the girl was indeed missing. It was also learned that certain marks found in the shoes had been placed there by the institution when the shoes had been issued to the girl. The girl had been seen last by other inmates escaping from the institution and boarding a freight train. It was confirmed by her friends that the girl had been a heavy smoker of the brand of cigarettes found in the clothing.

Fig. 5—Skull showing bullet entrance wound in center of forehead. The .22 caliber bullet was found inside the skull.

Case II. The cause of death in case II was a bullet wound of the head (Fig. 5). X-rays of the head revealed the bullet

in the brain and the presence of only half of the body of the 6th cervical vertebra. The edge of that vertebra was smoothly cut through by some heavy, sharp instrument.

The hair and skin were those of a Caucasian and the skull measurements substantiated this conclusion. The teeth were well preserved (Figs. 6 and 7). There were several carious cavities and some amalgam fillings as well as a mesial movement and inclination of the left upper third molar due to loss of the second molar.

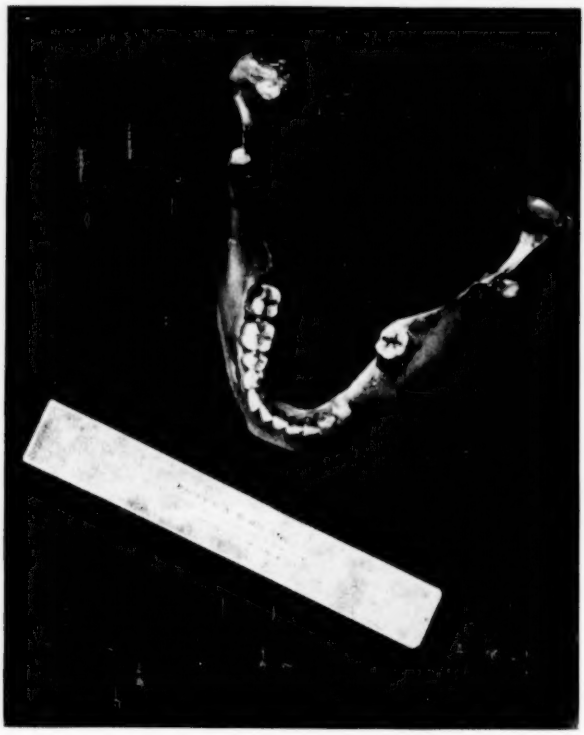

Fig. 6—Lower jaw. Note fillings and extractions.

With our description, the police finally turned up with the name of a missing taxi driver closely matching our findings. This man had served in the Navy during the war, so a photostatic copy of his dental record made at the time of his discharge was obtained. Except for one tooth that was pres-

ent in the dental chart and not present in the skull there was no doubt about the identity. Then the wife gave the name of the dentist who had extracted that tooth and the identity became positive.

Fig. 7—Upper jaw.

This was a relatively simple case. We always feel fortunate in these identification cases where the individual is under 35 or 40 years of age because of the great likelihood of the person having been in military service or employed in a war industry where medical records were kept. In these cases, of course, it is immaterial if any other parts of the body are ever found since the identification can be conclusively made if teeth or intact fingers are found.

Case III. In this third case an almost complete skeleton was found in an undeveloped wooded area within the city limits. There were no physical findings to indicate the cause of death. The soft tissues were completely gone. The intact pelvis was obviously male and the clothing on the bones was that usually worn by males.

Long bone measurements indicated a height of about 66 inches. The skull had typical Caucasian measurements, contour and proportions. Age was estimated between 55 and 60 years. The teeth had been absent for some years before death. There was an old healed fracture of the nose and the left zygomatic arch which gave a deviation of the nose to the left and probably a flattening of the left cheek.

The vertebrae showed marked osteo-arthritic changes with exostoses and lipping of the vertebrae, and a peculiar broadening of the left transverse process of the 5th lumbar vertebra.

The clothing bore several cleaning marks, the belt indicated a waist measurement of 33 inches and the name "Charlie Holmes" was stamped on one trouser pocket while the name "Sanders" was inked in the shoes.

The police were advised to check on a missing person of the above description. Some time before this study was completed an informant had told a sergeant of the local homicide department that a Willie *Saunders,* a colored male about 60 years of age, had been missing for some time. This Saunders, while on furlough as a patient from a regional Veterans Administration Hospital, had disappeared following a drinking bout. Believing that one good informant is worth several medical examiners, the sergeant decided to check on this Saunders despite our report that the skeleton was that of a white male.

The hospital authorities informed him that a William Saunders was one of their missing patients, and, furthermore, that a Charlie Holmes had been a patient in the same ward with Saunders. Following up this lead, we found that x-rays had been made of Saunders during previous admissions to the hospital. The x-rays were not made to show the vertebrae, but the composite picture shows unmistakably that the verte-

brae of our skeleton match exactly the vertebrae of Saunders (Fig. 8). As further proof, an x-ray of the skull of Saunders showed an old healed fracture of the nose.

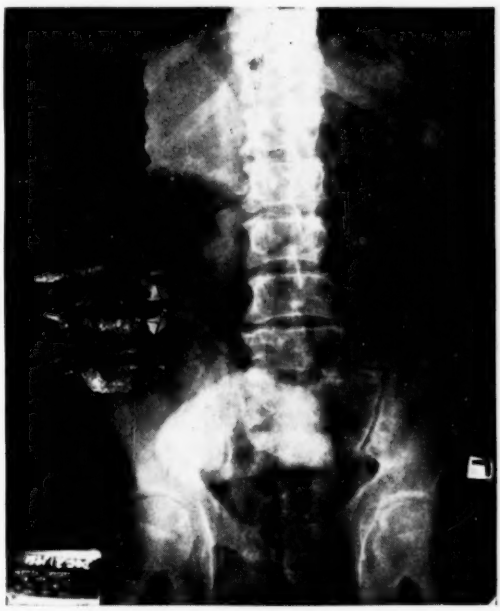

Fig. 8—Composite photograph of vertebrae and x-ray. Note arthritic changes in vertebrae which are identical with the bony changes seen in the x-ray.

The case illustrates how mixtures of races must be considered when estimating race from an assessment of the features of the skull.

Case IV. The last case is one in which we believe identification to be established but the evidence is such that a jury might find reasonable doubt as to the identity where a charge of homicide is involved, so it has not yet been brought to trial. The police believe they know the identity of the murderer and he has even been given a chance to confess, but he has declined the offer and is a free man at this time.

A summer mountain cabin was found burned to the ground one Friday morning. In the still smoking debris was found

the charred remains (Fig. 9). These remains and the surrounding ashes were brought to our laboratory.

Fig. 9—Charred remains found in burned cabin. Note ends of ribs protruding from the remains in lower right portion of photograph.

Routine x-rays revealed no bullets in the remains. The blood found coagulated in the great vessels was unsatisfactory for determination of carboxyhemoglobin or other toxicological determinations. Examination of the bronchi and trachea was not helpful in determining whether death occurred before or after the fire was started. The skull and brain were destroyed by the fire. The cause of death was never definitely determined.

Height could only be estimated within a range of six inches since a portion of the shaft of the femur was missing and none of the other long bones were intact.

X-rays of the pelvic portion were interpreted by a roentgenologist as that of a young female about 18 years of age who probably had some mild chronic inflammatory condition of the right hip.

An anthropologist was unable to determine the sex since the critical portions of the pelvis were burned away. The pelvic organs appeared to be completely destroyed, but since the finding of male or female sex organs seemed the only way to determine the sex, a painstaking dissection of the organs was performed. All tissue not positively identifiable was separated and sections made for microscopic examination. One portion of tissue was readily identifiable as the uterus with the endometrium in late follicular phase (Fig. 10) about the middle of a menstrual cycle.

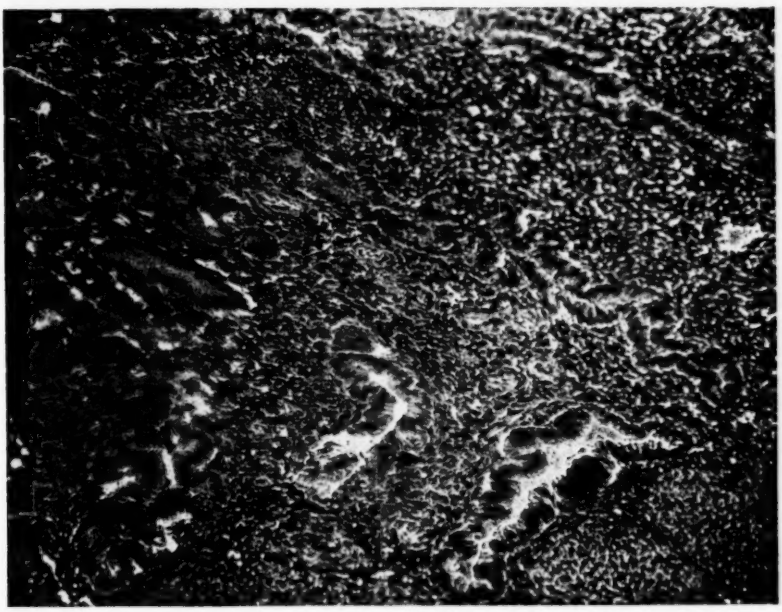

Fig. 10—Photomicrograph of section of endometrium. Note preservation of cellular detail despite charred condition of remains.

The nonmedical evidence in this case consisted of the presence in the ashes around the body of a brassiere hook, the metal parts of some blouse buttons, a fused glass-like mass thought to be a large coat button and some charred fragments of material thought to be rayon.

Several days later the police in a nearby town were notified by a mother that her daughter had not returned from a week-end trip. The daughter's description fitted with what little we could learn from the remains. The daughter had left with her Army sergeant husband the Thursday before the cabin was found burned. The husband had returned to his camp before the end of his three-day pass. The tire treads of his car matched those found on a road beside the cabin. He admitted being there with his wife but said he had later driven her back to town and let her out three blocks from home. Her overnight case was found in his possession. Since we cannot say with absolute certainty that the remains found are those of the missing girl the case has not been prosecuted.

There are many points of similarity such as the age, height, clothing, presence at the scene and, most persuasive of all, a menstrual period just fourteen days before she disappeared. Unfortunately the hip joint was not examined microscopically to determine the cause of the mild chronic inflammatory change seen on x-ray because several months later the mother of the girl was sent to a sanatorium with a diagnosis of far-advanced tuberculosis. In the meantime the skeleton had been accidentally discarded. If examination of the hip joint had revealed evidence of tuberculosis involvement it would have been a strong circumstantial fact to aid in the prosecution of this case.

Summary. We have tried to illustrate how some of the problems in identification of human remains which confront the forensic pathologist may be solved by the application of medical and nonmedical methods of investigation. These problems require first, the realization that a great deal can be learned from the most unpromising of remains on first appearance; second, that no scrap of evidence should be overlooked; and third, that the nonmedical methods are as important as the medical methods of investigation.

The forensic pathologist should be proficient in the allied medical specialties to aid in his investigation and he should have knowledge of the sources of information he must seek to make the final positive identification.

Office of the Chief Medical Examiner
404 North 12th Street
Richmond 19, Virginia

Forensic Pathology Slide Seminar*

Conducted by Arnold F. Strauss, M.D., Norfolk, Virginia

Case 8. Diagnosis: Hemorrhagic Encephalopathy Due to Mercury Poisoning

History: A white male, age 29, was admitted to the hospital after a sudden onset of nausea and vomiting. Temperature rose to 104° F., and he became comatose. Terminally, there was albuminuria and oliguria. Death occurred seven days after admission.

Case referred to Medical Examiner because poisoning was suspected.

Discussion: Two types of changes are seen in the microscopic sections of the liver: Postmortem shrinkage of ganglion cells and glial tissue, and hemorrhages. They are of ball type without recognizable central vessel. (Figure 1.) Some are perivascular and a few of ring type with uninvolved tissue between vessel and erythrocytes due to diapedesis from capillaries surrounding the larger vessel. There is apparently no demyelinization. The hemorrhages are not causing or connected with necrosis and, therefore, no microglial reaction is present. A myelin sheath stain showed no changes. Sudan stained fat droplets were present in endothelial cells of arterioles and capillaries. No proliferation, no thrombosis, as seen in more severe endothelial damage, can be found. Inflammation is absent.

We are dealing with a hemorrhagic encephalopathy, often called hemorrhagic encephalitis. This is not a specific lesion. A multitude of factors can cause it (1, 2). It is a signal for further investigation in several directions and the possible causes are worthwhile considering from a forensic viewpoint.

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* Presented at the Annual Meeting of the American Academy of Forensic Sciences, February 25–27, 1954, Chicago, Illinois. [Cases 1–7 appeared in previous numbers of this journal.]

Blood dyscrasias, in which lesions are generally not confined to the brain, must be ruled out. Numerous infections, such as influenza, diphtheria, and scarlet fever, will generally leave other telltale marks. Hemorrhagic encephalitis due to virus must be kept in mind. Malaria, generally with pig-

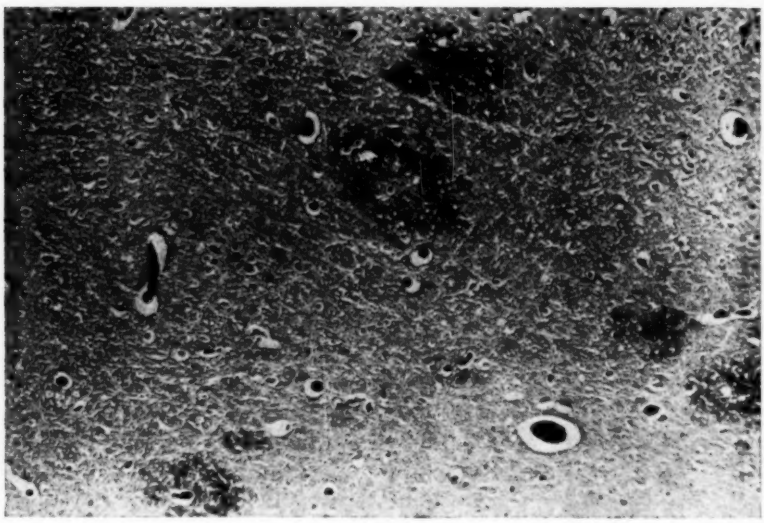

Fig. 1—Ball-hemorrhage upper right center, ring-hemorrhage upper center, perivascular hemorrhage lower left.

mented endothelium and parasites in vessels, is of forensic importance as a cause of death. Trauma and electrocution may cause petechial hemorrhages of the brain. Heatstroke may be responsible. Anoxia from high altitude, pulmonary disease or death from anesthesia and poisonous gases may produce these changes. Endogenous causes are uremia, eclampsia, and diabetes.

A number of poisons will lead to punctate hemorrhages: *Arsenic,* especially arsphenamine, generally causes more severe vascular injury. *Lead* often produces demyelinization and a homogenous material in the perivascular spaces, believed to be specific. *Alcohol* causing dietary deficiency tends to affect the subventricular area in the mid-brain and may produce glial reaction and nerve cell changes. Hemorrhages in the nuclear mass near the ventricles and around the oculomotor nuclei are characteristic of Wernicke's polioencephalitis

hemorrhagica superior. *Barbiturates* may cause endothelial proliferation in the cortex with acute severe ganglion cell changes. *Cocaine* will do the same to a lesser extent. *Phosphorus* causes petechiae at the floor of the fourth ventricle, chromatolysis and fatty degeneration of cortical cells and has numerous other characteristic findings. The same is true for mushroom poisoning. *Carbon monoxide* poisoning prefers the internal capsule and the globus pallidus, often with more extensive destruction of the brain tissue. *Manganese* seems to exert its primary effects on the blood vessels. Fatty degeneration of the capillaries and atheromatous changes in larger vessels have been described. Small focal hemorrhages and infarctions may occur.

Our case showed a surprising result on toxicological examination. It was due to mercury. The renal changes were compatible with mercury poisoning. Cerebral changes from mercury are apparently somewhat more common than less toxic compounds of mercury chloride. They are described as occurring after inunction with mercury ointment for syphilis and in thermometer manufacturing (4). Cerebral lesions have been reported following the fungicidal agents, diethyl and methyl mercury (3).

The range of poisons causing hemorrhagic encephalopathy seems to be unlimited.

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Case 9. Diagnosis: Spleen with Siderofibrotic Nodules Due to Sickle Cell Anemia

History: A 15-year-old Negro male had a slight toothache for several days which became quite painful, and one morning he began to vomit, had diarrhea and complained of headache. Later he had abdominal and leg pains. He expired 24 hours following the episode of vomiting.

Case referred to Medical Examiner because the death followed an unexplained rapidly fatal illness.

Discussion: In the spleen we see severe stasis, mainly in the cords, the blood storage spaces. Sinusoids are empty, follicles show severe congestion with aneurysm-like dilatation of their capillaries. (Figure 1.) The cause of all this is

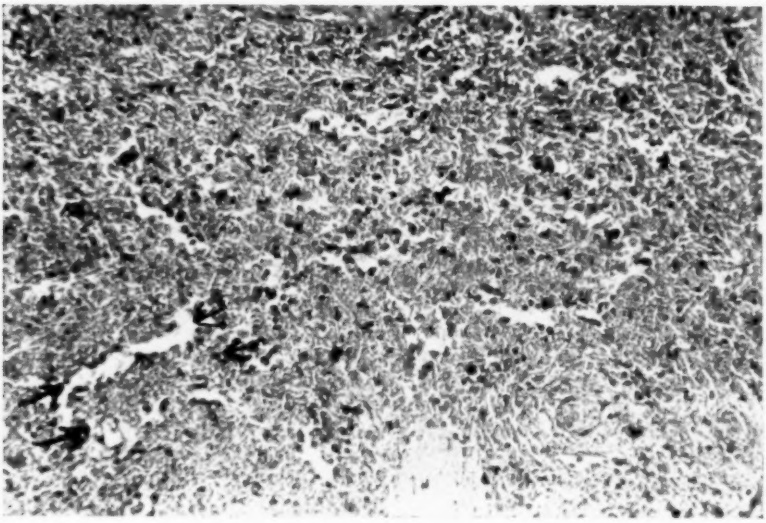

Fig. 1—Stasis in cords of spleen (lower pointers), empty sinusoids (upper pointers).

sickled, stiffened erythrocytes. An iron reaction reveals severe hemosiderosis in and at the fibrous structures, but not conspicuous in the pulp. Here endothelial reticulum cells are possibly unable to function because of anoxia from stasis and mechanical pressure of erythrocytes. The more resistant parts are the trabecles and arterioles. Here cells are able to react and take care of destroyed erythrocytes. Cells from the outskirts of arterioles proliferate and lay down fibers. We see fibrosis about the arterioles where they branch off the trabecles. (Figure 2.) The same happens at the periphery of the follicles, which do not have the rich supply of blood channels of the red pulp, where overstuffing of cords leads to stasis and anoxia. The beginning of these changes has been interpreted, erroneously I believe, as malformation of the spleen (12). In the periphery of the fibronodular proliferation about

the arterioles in these more cellular areas, erythrocytes are phagocytized and deposited as hemosiderin. Often, slightly more toward the center where tissue undergoes necrosis, we see foreign body giant cells. Iron and calcium are deposited by absorption on collagen and elastic fibers from tissue fluid saturated with iron, deriving from destroyed erythrocytes. Brush-like bamboo sticks of iron calcium incrustations form. These were described by the earlier authors as fungi with fructiferous organs (6), a theory easily supported by mold-contaminated cultures.

Fig. 2—Siderofibrotic nodules form where arterioles branch off the trabeculae.

No infarcts are present in our case. Thrombosis rarely occurs (7).

We see a spleen of sickle cell anemia with siderofibrotic nodules, the so-called Gamna-Gandy bodies, common, but in no way specific, for this anemia (Figure 3). Nor are they for the spleen, since they have been observed in areas of hemorrhage and necrosis as in goiter nodules and in ovaries (8). In the spleen they occur in diseases with portal hypertension or with erythrocyte destruction as in hemolytic jaundice and Mediterranean anemia. Rarely do they show the same

massiveness as in sickle cell anemia or lead to final atrophy of the originally enlarged spleen to a small knob.

During the last years, insight into the mechanism of the disease and the process of sickling has grown by leaps and bounds. We have learned that sicklemia without anemia can lead to crisis (4). Experiences of the Air Force (2) have

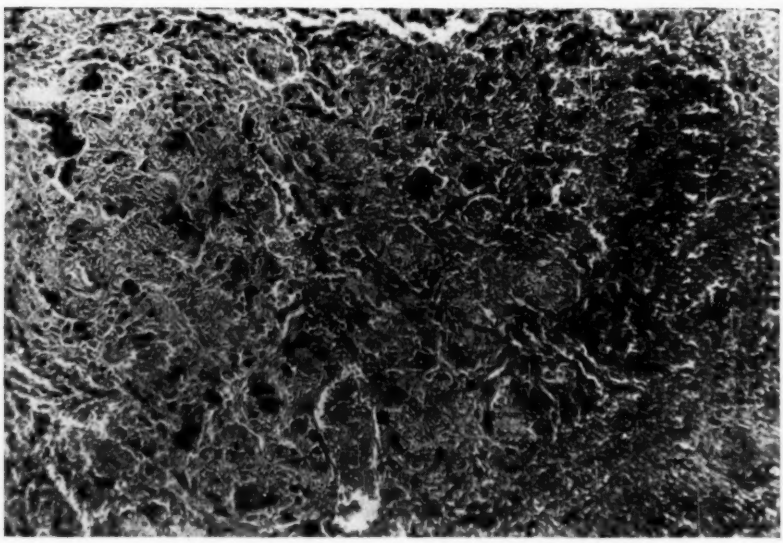

Fig. 3—Fibrosiderotic nodule with hemosiderin deposition at outskirt (right). Giant cell and iron calcium incrustation center and left.

shown that high altitude flying of Negroes with sickle cell trait will lead to a severe crisis with massive infarction of the spleen necessitating splenectomy. From a forensic view this is important. Crises may become the cause of death even in trait-cases, where the autopsy will not reveal signs of previous attacks. Dr. Mann (9) observed cases of severe, but nonlethal, alcohol poisoning with sickle cell crisis as the cause of death in previously healthy Negroes who showed at autopsy no organic changes other than those of the acute attack.

Sickle cell crisis has convinced me of the life-saving value of medical-legal autopsies in operative and postoperative deaths. In 1945–47 I observed four cases of operative death

due to sickle cell crisis (two laparotomies due to sickle cell crisis, a cholecystectomy for cholelithiasis, a circumcision in a boy 18 years old). Following this experience the staffs of all hospitals in which I worked introduced the rule that Negroes cannot be operated upon without being tested for sickling which, with sodium metabisulfite (1%), can be done in a few minutes. Since that time we have not had a single operative or postoperative death from sickling. Today it would appear to be almost criminal neglect to operate on Negroes without previous sickling tests.

Cerebral hemorrhage can pose a difficult problem in sicklers and we must be careful not to impede a criminal investigation because we find sickle cell crisis; nor should we forget that sickling rather than an insufficiently proven or minor blow may be the cause of death from hemorrhage.

New insight in the process of sickling itself may, on occasion be of value in forensic methodology. Sickling is due to an electrophoretically different hemoglobin which in reduced form crystallizes and forms tactoids, thin, spindle and rod-shaped particles with equidistant arrangement of the molecules, identical in appearance with the sickled erythrocytes. The latter practically consist of tactoids surrounded by a cell membrane (10, 13).

There are five different known hemoglobins: the normal adult type A, the fetal type F, the sickling type S and two other rare abnormal types C and D. In sickle cell anemia there is 76–100% of S combined with F; in trait 20–50% of S combined with A (13). Since about 8% of the colored population has sickle cell trait and since the percentage of S and F, or S and A is variable, differences in hemoglobin composition might be used similarly to blood groups in identifying blood. Gelling point determination of the lowest hemolysate concentration at which gelling occurs can be used for distinguishing anemia and trait blood (15). Immunologic specificity exists for A and F and may be used for distinguishing fetal from adult blood. It also allows the quantitative determination of the F or A component in sicklers which varies greatly between different persons (1, 5). The table shows the known characteristics of the different hemoglobins and their nosologic effects (10, 11, 13, 14).

Symbol of Hb	Name of Type	Electrophoretic Movement	Chemical Characteristics	Occurrence
A	Normal adult	Slower than "S"		SCT; C; variant of SCA; D variant of SCA; Not present in classic SCA
F	Fetal	Like "S"	Alkali-resistant	SCA; Thalassemia major; not present in SCT
S	Sickling			SCA: heterozygous; C and D variants of SCA; SCT homozygous; Thalassemia-Sickle cell disease
C	Nonsickling variant	Faster than "S"		C variant of SCA (mild disease in Caucasians) (S + C) homozygous mild hemolytic anemia; heterozygous (C trait) target cells only
D	Nonsickling variant	Like "S"		D variant of sickle cell disease (S + D) in Caucasians

SCT—Sickle cell trait
SCA—Sickle cell anemia

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Case 10. Diagnosis: Acute North American Blastomycosis of Lung

History: A middle-aged Negro male was admitted to the hospital in a moribund condition with a high fever. He expired before any examination or laboratory studies could be done. Autopsy revealed acute lobar pneumonia.

Discussion: The lung is diffusely consolidated by a purulent and fibrino-purulent exudate with occasional mononuclears and mononuclear giant cells. (Figure 1.) There are similar focal changes in the otherwise uninvolved part of the lung separated by a septum. The pleura has adhesions, much

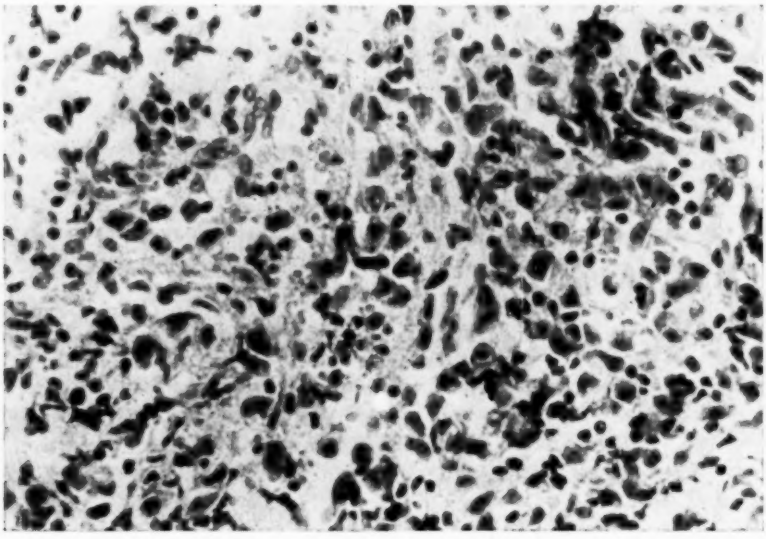

Fig. 1—Predominantly mononuclear pneumonia with fungi (pointer).

anthracosis and a single lamellated hyalinized nodule. There are a few hemorrhages. The arteries of the involved area present a proliferative endarteritis with plasma cells, slight lymphocytic and some neutrophilic infiltration. The bronchi are filled with exudate and their walls are ulcerated. In the exudate numerous fungi, large yeast-like cells with double-contoured membranes, occasionally with multiple nuclei are observed. (Figure 2.) Sometimes single small buds within the membrane or larger ones outside of it can be observed.

These characteristics are diagnostic for Blastomyces dermatitides. We are dealing with an acute pulmonary blastomycosis of North American type. The table shows the characteristic appearance of pathogenic fungi in tissue and the reactions they cause (1, 6).

To the forensic pathologist monilia infections, especially monilia endocarditis in addicts who inject narcotics such as heroin hydrochloride intravenously to themselves, is the best known fungus disease (6). Occasionally the question of compensation may arise in mycoses: Aspergillosis has been observed in fur cleaners who use rice powder, in thrashers who work in grain dust, and in France in squab feeders who take grain in their mouth to moisten it. South American

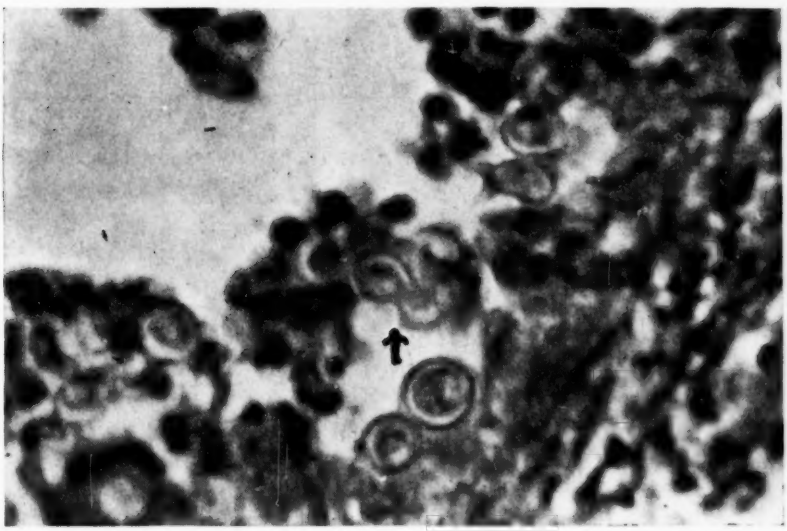

Fig. 2—Double-contoured fungi. A budding cell with common membrane (pointer).

blastomycosis is common among laborers in coffee plantations and may develop at sites of injuries. The tea-tasters in Ceylon are subject to moniliasis, and the lumbermen in the northern forests of our continent may develop allergic pneumonia from Coniosporum corticale growing on the inner bark of maple trees (5). The sources of many fungi are unknown. Sporotrichum lives on plants and coccidiodes in dusty soil.

FUNGUS IN TISSUE

DISEASE	NAME	SIZE IN MICRON (u)	CAPSULE AND WALL	BUDDING AND SPORES
North American Blastomycosis	Blastomyces dermatitides	(3) 5-20	Double contour, thick-walled, round	Single bud, capsule pushed out by smaller spores
South American Blastomycosis Paracoccidioidal granuloma	Paracoccidioides brasiliense	10–60	Same	Multiple small buds (1–2 to 10 u) covering part or whole surface of cell, break away from it in groups
Coccidioidomycosis	Coccidioides immitis	20–80	Thick-walled spherule with double refractile wall	Endospores 2–5 u
Cryptococcosis Torulosis European Blastomycosis	Cryptococcus neoformans Torula histolytica	5–20	Very large mucoid capsule thick-walled	Single bud
Sporotrichosis	Sporotrichum Schenckii	1.5–25 3–6.5	Polymorph, often cigar-shaped, occasionally bacilliform	Fusiform buds at end of cell
Histoplasmosis	Histoplasma capsulatum	1–4	Thick refractile capsule	Buds
Moniliasis	Monilia or Candida albicans	2.5–4–6		Many spores, budding forms, with occasional thick-walled rounded cells 5–15 u
Aspergillosis	Aspergillus fumigatus	3–6 (diameter)		Generally none
Mucormycosis	Mucor mucedo	3–18 (diameter)		Generally none

HYPHAE	OTHER CHARACTERISTICS	SOURCES OF ERROR	REACTION OF TISSUE
		Single buds in South American Blastomycosis Immature spherules of coccidioides Dwarf forms (3 u) similar to histoplasma	Skin: pseudoepitheliomatous hyperplasia; tubercles, giant cells, but little caseation or diffuse infiltration with abscess (lung)
		Immature spherules of coccidioides	Like North American Blastomycosis, less suppuration, more fibrosis
			Early purulence with giant cells and mononuclears; abscess surrounded by plasma cells, lymphocytes and mononuclears; center: tuberculoid with caseation
	In giant cells or jellylike masses	If capsule absent taken for blastomyces	Nonsuppurative; early little reaction, later tuberculoid; caseation rare
	Rarely seen in tissue		Three, somewhat overlapping zones: abscess, palisading epitheloid cells, lymphocytes and plasma cells
	Multiple in reticulo endothelial cells, occasionally extra cellular	Leishmania toxoplasma	Proliferation of mononuclear cells; occasionally somewhat nodular, occasional caseation
Little branching, rounded ends 2.5 x 4-6		Spores may be mistaken for Blastomyces Pseudo-hyphae without budding forms resemble aspergillus	Abscesses later, surrounded by macrophages; occasionally tuberculoid
Septate branching	In late stages actinomyces like bodies		Necrosis, with polymorphonuclears, mononuclears, giant cells
Large very long with lateral branches; no septa; marked irregularity in width			

Trauma may lead to infection (5). The forensic pathologist must keep in mind that fungus diseases can be occupational. The claimant may be entitled to compensation.

The geographic distribution (1, 5) of certain fungi may, on occasion, be helpful in determining the area in which an unidentified person has lived. Coccidiodes infections are acquired in the dry, sandy and dusty areas of the Southwest. Histoplasma, though universal, is common in the Mississippi Valley, Missouri, Kansas, Tennessee, Kentucky and Ohio. North American blastomycosis likewise is often found in the Mississippi Valley and occurs in the southeastern states.

Though these diseases are not contagious there may remain in undiagnosed lung lesions a question of public interest, the Hamlet question, T.B. or not T.B.

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Case 11. Diagnosis: Rabies

History: A Negro male, age 34, received a medical discharge from the Army in 1945 because of asthma. He was only able to work part time as an attendant at an animal hospital. On August 14, 1953 he began having episodes of pain in the left hand, arm and shoulder regions. These increased in severity, but subsided after four days and were associated with episodes of shortness of breath. He was treated by a local physician with penicillin and ephedrine. On August 20, 1953 he was unable to drink liquids and was admitted to the hospital. There he was found to have a normal temperature and intermittent episodes of hyperventilation and opisthotonos. The

next day he became highly agitated and was placed in a security ward. His intolerance to liquids persisted. On August 22, 1953 he ran a temperature of 104° F. and had profuse brownish salivation.

Case referred to Medical Examiner because of possible public health problem.

Discussion: There is a rather narrow dense band of ganglion cells of the cornu ammoni with perivascular round cell infiltration in meninges and adjacent areas of the brain. (Figure 1.) Many ganglion cells are degenerated and may

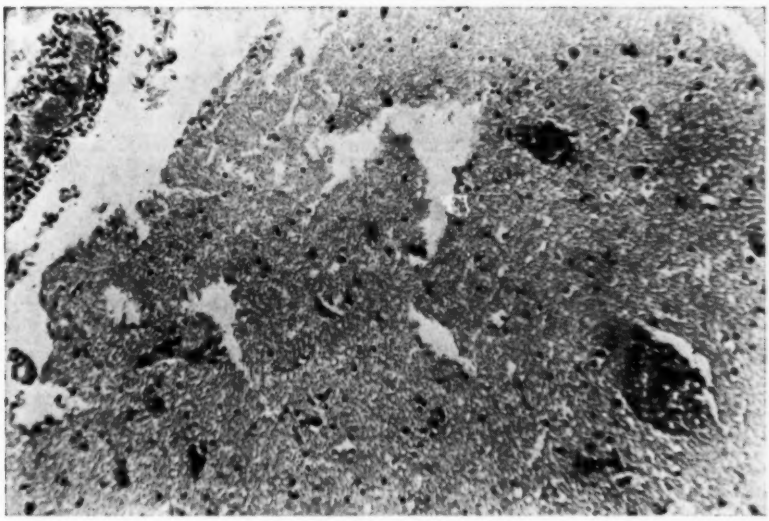

Fig. 1—Perivascular round cell infiltration.

show satellitosis. Occasionally in the larger ones we find acidophilic inclusions of various shapes, often fairly large and located in the dentritic process. (Figure 2.) These Negri bodies are more clearly seen in imprints. They allow us to make a diagnosis of a specific encephalitis, often so difficult, or only possible by virus studies. This case we are presenting is one of rabies. Distribution of lesions and type of cellular exudate is fairly characteristic of certain types of encephalitis. But, as long as we find Negri bodies which are present in 70% of human cases and in 90% of canine brains, we do not have to worry about the intricacies of neuropathology.

In rabies, lesions are most extensive in the thalamus, pons, medulla and in the spinal cord, in the latter especially in regions related to the site of the bite (2, 4). Herzog (3) pointed to the severe ganglion cell degeneration of the ganglion nodosum of the vagus which, according to him, are never found in other diseases, though it may be better to substitute "rarely" for "never."

Fig. 2—Negri body in ganglion cell (pointer).

Rabies is not only a problem to public health, but in Latin America, especially in Mexico and Brazil, an economic one. Severe losses of livestock, up to 60%, are caused by bites of vampire bats, virus carriers, in which rabies is enzootic (7).

If rabies is suspected the brain should be removed with a minimum of contamination to facilitate animal inoculation. Imprints colored with Sellers fixative stain will reveal purplish red inclusions when taken from hippocampus (6) imprints and also from each side of the cerebellum and cerebral cortex (1 imprint each) (4). If no Negri bodies are found the material from these areas can be pooled, if necessary sterilized with penicillin and streptomycin and injected

intracerebrally into mice. For 21 days the animals should be observed for paralysis. They should be checked for inclusions (4).

Negri bodies show marked variation in size (2–30 mu.), are round or oval, occasionally distorted by the dentritic process. In dogs they may be easily confused with the inclusions of distemper. Negri bodies and distemper inclusions may both be vacuolated, but the former contain basophilic inner bodies. Distemper inclusions are both cytoplasmatic and nuclear, and occur in many other organs, especially in the epithelium of the urinary bladder. The diagnosis of rabies from the brain of dogs is, therefore, difficult and had better be left to those with experience (5, 6).

Mice may be host to small, very refractile, uniform inclusions without inner structures which must not be confused with Negri bodies or with the nonspecific small eosinophilic lyssa bodies seen in rabies.

Vaccine is not always innocuous and may cause severe demyelizing lesions (1). For the well-established rules for its use, textbooks should be consulted.

From the forensic viewpoint it is important to keep the possibility of rabies in mind. The clinical picture may be misleading, especially in paralytic forms. The history of a minor encounter with a dog may be missed in a disease, the incubation period of which can extend beyond one year. It is a compensable disease in people who work with animals, and double indemnity is due to the victim of an accidental death, as in our case.

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Correlation of Urinary Coproporphyrin III with Lead Intoxication*

Robert V. Blanke, M.S., Chicago, Ill.

Since the symptoms of lead poisoning are nonspecific and easily confused with other conditions, several clinical tests have been advocated to determine whether there has been an abnormally high absorption of lead. Most of these procedures are based on pathological changes produced by the absorbed lead, e. g., a decrease in hemoglobin, an increase in the basophilic aggregation count, or an increase in the number of stippled cells. However, due to the great variation of individual response, none of these tests is absolutely reliable. Since the excretion of abnormal amounts of lead in urine is an indication of its absorption, it has become common practice to determine the level of lead in blood or urine as an aid in the diagnosis of lead poisoning.

Lead analyses are time-consuming and consequently expensive. The amount of lead normally present in urine is about 30 micrograms per liter (3). Since lead is a common impurity in reagents and glassware, as well as in dusts, etc., elaborate precautions are necessary to avoid contamination. For these reasons it is desirable that a simple but accurate test be devised which would be a reliable index of lead poisoning.

The fact that coproporphyrin III is excreted in abnormal amounts in lead poisoning has been known for many years (10). However, not until recently have tests for this pigment been described as an index of lead poisoning (5, 6). Quantita-

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tive methods have also been reported (9). Pinto et al. (7) have clearly demonstrated the superiority of a coproporphyrin determination over other clinical tests for lead poisoning. We have used these methods in comparing the coproporphyrin excretion with lead excretion in cases of suspected lead poisoning. As a result, we believe that the demonstration of abnormal amounts of coproporphyrin in the urine of patients suspected of suffering from plumbism is a test both simple and reliable.

METHODS

Quantitative Determination of Coproporphyrin

Although the presence of porphyrin precursors has been known for many years, most investigators assumed that the chromogen was converted to the pigment during the extraction and purification procedures. This assumption has been shown to be false by several investigators. Watson's group (12) found that 46 percent of the total porphyrin in fresh urine consists of precursor. This chromogen is similar in many respects to a compound prepared *in vitro* by the sodium-amalgam reduction of coproporphyrin. Iodine in the ratio of three molecules of iodine to one of coproporphyrinogen converts the chromogen almost quantitatively to coproporphyrin. Watson's data indicate that the chromogen is similar to a reduced form of coproporphyrin, probably involving the addition of six hydrogen atoms to the four methene bridges and to two of the nitrogens (Fig. 1).

The method described by Schwartz et al. (9), in their excellent study of factors influencing the analysis of coproporphyrin, was used in our work. The extraction procedure was modified only in that the spark from a vacuum leak tester was applied to the side of the separatory funnel to hasten the separation of emulsions. Also, no preservative was added to the urine.

For fluorescence measurements a Beckman DU spectrophotometer with fluorescence attachment was used. The primary filter was a Corning Filter No. 5113 (5–58) which has a maximum transmission at about 405 millimicrons. Since the fluorescence spectrum of coproporphyrin in acid solution lies between 595 and 652 millimicrons (8), the secondary filter was a Corning Filter No. 2424 (2–63) which transmits a minimal

amount of light below 580 millimicrons. The blue-sensitive phototube was used which is relatively insensitive to light above 700 millimicrons.

A 10,000 megohm resistance was placed across the phototube circuit to increase the sensitivity. On our instrument the voltage applied to the grid of the No. 2532 amplifier tube had to be increased by moving the red lead of the No. 1 C battery

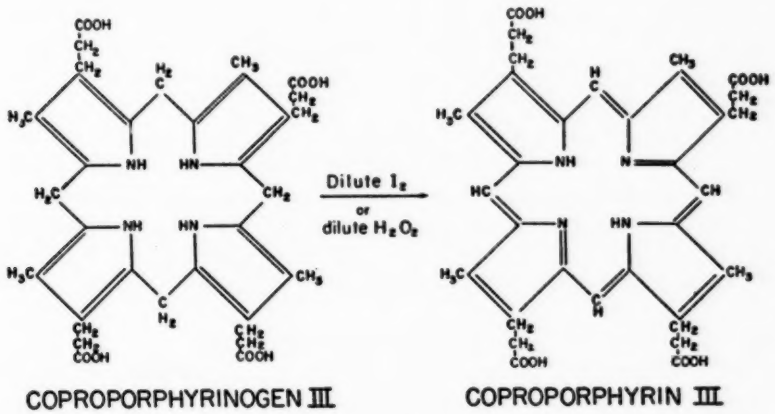

Fig. 1—Probable reaction in conversion of chromogen to pigment (12).

to a more positive terminal. With the selector switch set at O.1, the instrument was then operated as recommended by the manufacturer (1).

Qualitative Test for Coproporphyrin

In 1948 de Langen and ten Berg suggested a simple ether extraction of urine to determine the presence of coproporphyrin in lead poisoning (5). We have used the test as described by McCord (6). Due to troublesome emulsions, however, we have modified it as follows:

Ten ml. of urine are pipetted into a 125 ml. separatory funnel. Glacial acetic acid is added dropwise until the solution is acid to Congo Red paper. Five drops of three-percent hydrogen peroxide solution are added and the solution shaken with 50 ml. diethyl ether. The water phase is discarded. The ether is then extracted with 2 ml. of 1.5 N HCl. The HCl solution is drawn off into a Pyrex test tube and viewed under an ultraviolet light with Woods filter. If the fluorescence is

blue or blue-green, the test is negative; if it is pink or red, the test is positive.

Occasionally it is difficult to decide on the color of the fluorescence. This may be due to an impurity masking the fluorescence or to an incomplete conversion of the chromogen to the pigment by hydrogen peroxide. When this occurs, a quantitative determination is necessary to be sure of the amount of coproporphyrin present.

Although dilute iodine converts the chromogen to the colored pigment more completely, we have found that for the qualitative test, hydrogen peroxide is more convenient. If iodine is used, a slight, red fluorescence is observed when the urine contains a normal amount of coproporphyrin. Since it results in a purer product, 1.5 N HCl is used for the final extraction. Lower concentrations of HCl may not split the zinc-coproporphyrin complex which may be present, and higher concentrations remove colored impurities as well as tend to form fluorescence-quenching substances (9).

Quantitative Determination of Lead in Urine

For the analysis of lead in urine, a method must be used which has good precision and sensitivity with very low concentrations of lead. We have found the polarographic method to be adequate in this respect. Although it is not as sensitive as the dithizone method, it is much more convenient to carry out. Fewer manipulations are involved and hence there is less of an opportunity for contamination to occur.

The danger of contamination cannot be emphasized too strongly. In the laboratory where proper precautions can be taken, contamination can be controlled. However, when the twenty-four hour urine specimen is collected at the hospital or in the patient's home, the physician must instruct the patient to avoid contamination. It has been our practice to prepare Pyrex, glass-stoppered bottles of 2 or 4 liter size which are lead-free. Instructions for collecting the specimen are attached to the bottle. This is then given to the physician who either supervises the collection of the specimen or warns the patient of the possibility of contamination. Even with these precautions, specimens are occasionally received which are grossly contaminated with foreign material. Therefore, the possibility of contamination must always be considered in analyses of this type.

Reagents

(a) *Metal-free Water*—Laboratory distilled water was passed through a deionizing resin, after which it was distilled from potassium permanganate and redistilled. Both distillations were carried out in all-Pyrex apparatus. All water used in the procedure is metal-free water.

(b) *Twenty percent Citric Acid*—200 gms, of citric acid (C. P., A. C. S., Mallinckrodt, low lead) dissolved in and made up to 1 liter with metal-free water.

(c) *Standard Lead Solution*—1.5985 gm. reagent grade lead nitrate dissolved in metal-free water. Ten ml. concentrated nitric acid added and the solution made up to 1 liter with metal-free water. This is a stable stock solution containing one mgm. lead per ml.

Apparatus

Recording Polarograph, Sargent Model XXI.

All glassware used was Pyrex. Glassware was cleaned in the usual way (chromic acid, detergent) followed by a rinse with 1:10 nitric acid solution, thorough rinsing with distilled water and a final rinse with metal-free water. It is dried by heat.

Procedure

One hundred ml. of well-mixed urine from a 24-hour sample are pipetted into a 125 ml. Vitreosil evaporating dish and evaporated to near-dryness on the steam bath. After cooling, 10 ml. of concentrated nitric acid are added and the solution is evaporated to dryness. The dish is transferred to a cold muffle furnace and the temperature is increased slowly to 500° C. The residue is ashed at this temperature overnight. After cooling, the residue is treated with 5 ml. of concentrated nitric acid, evaporated to dryness, and again placed in the furnace at 500° C. for about one-half hour. This treatment results in a pure, white ash. The ash is treated with 5 ml. of concentrated HCl and evaporated to dryness. It is then treated with 10 ml. of 1:4 HCl, warmed to effect solution and reduce the volume, and transferred to a Heyrovsky electrolysis cell. The dish is washed twice with 2 ml. portions of hot water and the washings added to the cell. The combined solutions are then evaporated cautiously on a hot plate. We have found it convenient to direct a source of infra-red light on to the

surface of the liquid. Also, when the level of the liquid has dropped sufficiently, a stream of clean, dry air is pulled over the solution through the gas inlet to hasten the evaporation. After the residue is dry and HCl free, it is cooled and 5 ml. of 20 percent citric acid solution are added. The level of the solution is marked on the cell (or a cell calibrated at 5 ml. may be used) and the solution heated to gentle boiling and maintained at this temperature for 10 minutes. After cooling, water is added to bring the solution back to 5 ml. The polarogram is then made at 25° C. at the highest sensitivity possible.

The concentration of lead may be calculated in various ways. We use the standard addition method (4, p. 377–379). This method is also a check as to whether the observed half wave potential is actually due to lead. In 20 percent citric acid, the half wave potential for lead is — 0.60 v. (uncorrected), but if some HCl is still present, the potential is about — 0.45 v.

This procedure is sensitive to 1 microgram of lead. Repeated blank determinations show 1 microgram of lead or less. Recovery of added lead is 98 percent with a standard error of ± 4 percent.

RESULTS

Comparison of Qualitative and Quantitative Methods for Coproporphyrin

Twenty-two cases were analyzed quantitatively for coproporphyrin. Six of these fell in the normal range of less than 180 micrograms per day (8). Of these 6 cases, 5 gave negative qualitative tests. The one case which gave a positive test was at the upper limit of the normal range. Sixteen cases contained abnormal amounts of coproporphyrin. These ranged from 0.26 to 4.7 mgm. per 24-hour specimen. Of the 16 cases, 14 gave positive qualitative tests, while two were doubtful.

Comparison of Qualitative Coproporphyrin Test with Lead Level in Urine

In the 140 analyses carried out, the criterion for lead intoxication was demonstration of abnormally high lead levels in the urine (greater than 80 micrograms of lead per liter [3]). Seventy-six cases were in the normal range; five of these gave positive tests for coproporphyrin, three were doubtful, and 68 were negative (Fig. 2).

Urinary Lead Range (micrograms/liter)	Number of Cases (total =140)			
	Test for Coproporphyrin Positive	Test for Coproporphyrin Doubtful	Test for Coproporphyrin Negative	
			A	B
0 - 80 (Normal)	5	3	68	-
80 - 100	4	0	3	2
100 - 200	19	3	5	1
200 - 300	10	0	0	2
300 - 400	3	0	0	1
400 - 500	2	0	1	0
500 - 600	2	0	0	0
600 - 700	2	0	0	0
700 - 800	2	0	0	0
800 - 900	2	0	0	0

A = Single Specimen Analyzed for Lead
B = First Specimen - Pb Abnormal; Other Specimens, Pb Normal

Fig. 2—Comparison of qualitative coproporphyrin test with urinary lead level.

Of the 64 cases which fell in the abnormal lead range, 46 gave positive tests for coproporphyrin, three were doubtful, and 15 were negative. In 6 of the 15 cases which showed abnormal lead levels but normal coproporphyrin levels, an additional 24-hour urine specimen was obtained, using more careful precautions to avoid contamination. In each case, the subsequent lead analysis fell in the normal range. This indicated that the original specimen had inadvertently been contaminated. Unfortunately, a second specimen could not be obtained in the remaining 9 cases.

Discussion

The excretion of abnormal amounts of coproporphyrin in the urine can be caused by several factors (11, 2, 13). However, when this condition exists in a patient with a history of exposure to lead or with other symptoms of lead poisoning, it is very probable that lead intoxication is the causative factor. Since the qualitative coproporphyrin test described above does differentiate between normal and abnormal excretion of coproporphyrin, it should be of value to the clinician as a further aid in the diagnosis of lead poisoning.

The test is also of use to the analytical toxicologist. It has been our experience that about one-half of the specimens submitted to us for lead analysis have been normal with respect to lead. With the use of this test, most of the normal cases can be eliminated without a lengthy, expensive lead analysis. Also, if the lead level is very high and the coproporphyrin test is normal, it is very possible that contamination of the specimen has occurred and the results of the lead analysis are not valid.

Summary

A qualitative test for urinary coproporphyrin as well as a quantitative method for the determination of urinary lead are described.

When compared with a quantitative determination of coproporphyrin, it was observed that the qualitative test distinguishes between normal and abnormal amounts of coproporphyrin in urine.

In 140 cases of suspected plumbism, the results of the qualitative test were compared with the quantitative determination of lead in urine. It was observed that almost all cases of high lead excretion were associated with abnormally high coproporphyrin excretion.

About one-half of those cases showing normal coproporphyrin but high lead levels were re-examined under more carefully controlled conditions. In each case the lead level was found to be in the normal range.

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The author is indebted to Dr. C. J. Watson and Dr. Samuel Schwartz of the Department of Medicine, University of Minnesota, for supplying a standardized sample of coproporphyrin I as well as much valuable information concerning porphyrins.

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AGAMMAGLOBULINEMIA: Factor in sudden deaths in infants. The recent report of sudden and unexpected death in three infants who had exceptionally low gamma globulin content in serum protein adds one more link to the chain of evidence accumulating to connect immune mechanisms with gamma globulin. Serum gamma globulin levels within six hours of death were 150, 183 and 180 mg. per 100 cc. Ages of the three infants were six, nine, and five weeks. Sex of the infants was not stated.

Spain et al., authors of this report, point out that antibodies received by an infant from its mother during fetal life usually disappear by the second or third month. It is in this critical period that the serum content of gamma globulin, high at birth, rapidly declines to a low level as the infant's liver begins to synthesize its own gamma globulin. Thus, while the fetal gamma globulin level may exceed the maternal level, the gamma globulin concentration in the infant's serum decreases during the first two months of life, begins to rise after three months but does not return to "normal" level until about the age of five years. An infant in whom gamma globulin is unusually low or absent, therefore, could be defenseless against ubiquitous respiratory infections.

Postmortem examination of the three infants whose sudden and unexpected deaths are reported by Spain et al. revealed acute upper respiratory inflammation and a few foci of inflammatory cells around the bronchioles. In two other infants whose sudden deaths were due to proved accidental mechanical suffocation and hydrocephalus, respectively, the gamma globulin levels were 500 and 600 mg. per 100 cc. Ages of these two infants were six and 11 weeks. From "What's New," #187, 1955, Abbott Laboratories, Chicago, Ill.

Examination of Blood Stains in Forensic Medicine*

Alexander S. Wiener, M.D., and Eve B. Gordon, Brooklyn, N. Y.

In 1938, a new laboratory was established in the Office of the Chief Medical Examiner of New York City, devoted primarily to the examination of blood-stained articles for use as evidence in homicide cases. During the course of a year, hundreds of articles are tested for the presence of dried human blood stains, and blood grouping tests are carried out on such stains wherever possible. The methods of examining dried blood stains are well known, and detailed descriptions of the technic can be found in standard texts on the subject (1–5). The purpose of this paper is to discuss certain principles and practical aspects of the tests and the interpretation of the findings, which generally are not mentioned in textbooks. That there is need for such an article can be seen from the appearance recently of a monograph which recommends methods of grouping blood stains which cannot possibly give reliable results (6).

Following the discovery of the Rh factor and the resulting development of special methods of detecting Rh-Hr antibodies, a new chapter in blood grouping research began. Many investigators in this country, in England, and in other parts of the world have applied these newer technics to test blood serums from individuals who have had blood transfusion reactions, and to test serums from mothers of erythroblastotic babies, and in this way numerous blood group antibodies, previously unknown, have been discovered. To date more than 25 different blood group factors have been identified in human

* From the Serological Laboratory of the Office of the Chief Medical Examiner of New York City, and the Department of Forensic Medicine, New York University Postgraduate Medical School.

blood cells, which fall into nine or more independent blood group systems (7). Thus, using presently available reagents, it is possible to demonstrate a high degree of individuality in human blood, confirming the correctness of a prediction made by the late Dr. Karl Landsteiner (8) a long time ago.

When a worker is confronted for the first time with the problem of grouping a dried blood stain, his tendency may be to attempt to apply these more recent discoveries regarding the human blood groups. He soon learns, however, that methods of grouping dried blood stains have not kept pace with the advances in grouping of fresh blood. In fact, the status of grouping dried blood stains today is about the same as it was in 1938 when our laboratory was first opened (9). The main advance is the increased understanding of the limitations of the tests and their interpretation. Once a blood stain has dried, one is fortunate to be able to classify it into one of the four groups O, A, B, or AB. Attempts to determine the subgroups of A, the M-N-S types, Rh-Hr types, and Kell types, etc., yield results not sufficiently reliable for medicolegal purposes, as a rule.

Examination of Fresh Wet Blood Stains

Blood grouping tests can never establish that a given specimen of fresh or dried blood came from any particular individual, but they may show that the blood stain could not have come from the individual in question. For example, if a stain contains human blood of group A, it could not possibly have come from a group B or group O individual; on the other hand, a blood stain of group A may or may not have come from a specific group A individual, since as many as 40 percent of the general population belong to group A. At the present time, so many blood groups are known that when tests can be carried out for enough blood groups factors, it is possible in certain instances to use the results as circumstantial evidence that a stain contains the blood of a specific individual. This information may serve as a valuable clue in the investigation even if not true. In practice, this has been possible only in exceptional cases, because only rarely are blood stains found before they have had time to dry. In such cases, by shaking up the blood clots in saline solution we have succeeded in preparing blood suspensions which could be typed directly like blood drawn from the vein.

Case 1. At 6:45 a.m. on May 1, 1955, M. M., a man 45 years of age, was found at a certain house suffering from head wounds which he stated had been inflicted by an unknown assailant. He was removed to a hospital where he subsequently died. Investigation revealed that this assault had been perpetrated by one P. P., in whose room and on the bathing beach nearby, blood stains were found. We were requested to examine the dried blood stains found on the table and floor of the room where the assault had occurred, and a sample of the blood clot taken from the beach where the victim was believed to have lain for some time before making his way home.

The stains obtained from the floor and table of the room were shown to contain dried human blood of group O. The blood clot obtained from the beach proved to be human blood having the blood groups O, MN, Rh_1Rh_1, f, p. Blood obtained from the victim postmortem was found to have the identical blood groups. Since group O has a frequency among Caucasoids of approximately 40 percent; type MN, 50 percent; type Rh_1Rh_1, 20 percent; type f, 35 percent; and type p, 25 percent; this particular combination of blood groups has the frequency (0.40) (0.50) (0.20) (0.35) (0.25) or only .0035. That is, if the blood on the bathing beach were not the victim's, the chance of its having his identical blood groups would be only about 1 in 300. On the other hand, for the dried blood stain on the floor, which could be classified as group O only, the chance of coincidence is as high as 40 percent.

Case 2. On December 14, 1954, we were requested to examine a specimen consisting of gauze sponges and blood clots which had been obtained in a case of criminal abortion. A blood suspension was prepared from the clots without difficulty and proved to belong to groups A_1B, MN, Rh_2. The frequency of this type in the general population is approximately (.04) (0.50) (0.15) = .003 or less than 1 in 300. To date, however, we have not been requested to type the blood of the patient, who is still alive. In similar instances in the past where we succeeded in showing that the blood type of the blood clots in the abortionist's office was identical with that of the victim, this helped to overcome the reluctance of such individuals to act as material witnesses.

Case 3. At 8:30 p. m. on January 10, 1955, a 35-year-old woman was hit on the head with a stone mason hammer by her male companion, who had been living with her in the same apartment. The assailant then dragged her into the kitchen and threw her out of the window, causing her to fall to her death 14 stories below. A specimen of blood obtained from her body was found to belong to group O, type MN, type $Rh_1{}^wrh$. In the bedroom of the apartment a bedsheet was found with a pool of blood on it which also proved to belong to group O, type MN, type $Rh_1{}^wrh$. Since the chance of coincidence was (0.40) (0.50) (0.16) or only 1 in about 300, this is strong circumstantial evidence corroborating the other evidence that the deceased had been in the apartment. In addition, a small piece of gray matter was found which on histological examination proved to be brain tissue, and

fingernails which had been missing from the corpse were also found in the apartment.

Case 4. On the morning of December 2, 1955 an abandoned automobile was found on a bridge. The owner had been missing for a number of days and had been known to be depressed by the fear that he had cancer. In the car a blood-stained razor was found, and pools of blood were found on the floor of the car. The blood was collected by the police in test tubes and promptly brought to the laboratory. It was a simple matter to prepare a blood cell suspension and the blood proved to be group A_1B, type MN, type Rh_1Rh_2. Unfortunately, when the body was subsequently found in the creek under the bridge, no blood could be obtained for comparative blood grouping tests.

In a case such as the one just described in which a blood suspension prepared from a wet blood stain is agglutinated by all the antiserums used, one must think of the possibility of panagglutination. The wet blood stain which we had examined had been removed from the floor of a car, and among the bacteria present might be some capable of rendering the erythrocytes of the blood stain panagglutinable. That our blood grouping results were valid was therefore established as follows: First of all, the agglutination reactions were uniformly strong and convincing, and the erythrocytes from the blood stain did not agglutinate when mixed with group AB serum. Moreover, when the erythrocytes from the stain were mixed with fresh group O cells and the mixture allowed to stand overnight at room temperature, the group O cells did not become panagglutinable. Since the agent responsible for panagglutination is transmissible, the presence of panagglutination was thus excluded, and the diagnosis of group AB confirmed.

Dried Blood Stains

When dealing with fresh wet blood stains, where blood suspensions in saline solution can be grouped directly, no special additional tests are required to prove that the stain is of human origin. The mere fact that the blood can be classified as belonging to a particular A-B-O group, M-N type, and Rh-Hr type, is in itself proof that the stain contains human blood, because blood from lower mammals including lower primates reacts quite differently in these blood tests (10). When dealing with *dried* blood stains, on the other hand, preliminary tests must first be carried out to establish the presence of human blood.

Chemical test for blood. Satisfactory descriptions of the tests for human blood can be found in the standard texts on the subject already cited. It is sufficient to point out here that these tests consist of two major parts, a presumptive chemical test for blood and a precipitin test to establish the human origin of the stain. The chemical test generally used depends on the catalytic action of hemoglobin in breaking down peroxide to release nascent oxygen. In addition to peroxide, an indicator such as benzidine, leucomalachite green, or reduced phenolphthalein is used, which when oxidized develops a characteristic color. In our own laboratory we use the reduced phenolphthalein and benzidine tests. One must bear in mind that a positive reaction indicates only the probable presence of blood, because there are other substances besides hemoglobin which have the capacity to release nascent oxygen from peroxide, or which can oxidize the indicator directly and thus bring about the color change. The test is so sensitive, on the other hand, that a negative reaction is strong presumptive evidence for the absence of blood.

Precipitin test. Extracts of stains giving positive chemical reactions for blood are further tested with rabbit immune precipitin serum, which is prepared by injecting human serum into rabbits.* Anti-human precipitin serums cross react with blood serums from lower primates, the heaviness of the precipitate being roughly proportional to the degree of zoological relationship. In fact, some antiserums, especially those obtained after prolonged immunization, cross react with blood serum from lower mammals (mammalian reaction); such poorly specific antiserums of course are not suitable for medico-legal work.

In some parts of the world the distinction between human and ape or monkey blood may be important in homicide cases, so attempts have been made to render precipitin serums more specific by absorption with blood serum from lower primates. The results of such experiments have been disappointing. Theoretically (8) more specific precipitin serums could be obtained by immunizing monkeys or apes with human serum, but no worker appears to have carried out such an experiment.

* Useful adjunct in these tests is anti-hemoglobin rabbit precipitin serum. Unfortunately, hemoglobin is a weaker antigen, so that such antiserums are not readily obtained.

At any rate, this limitation of the precipitin test is unimportant in a city like New York. After one of us had finished testifying in a certain murder case, the defense attorney asked, "Isn't it a fact, doctor, that you cannot state with certainty that this blood stain did not come from a monkey instead of a human being?" After it had been admitted that this limitation was correct, the district attorney arose and said, "We want the court to take judicial notice of the fact that ordinarily there are no monkeys or apes on Fifth Avenue and 42nd Street."

False negative precipitin reactions may be obtained with denatured human blood stains. The degree of denaturation depends on the age of the blood stain and the conditions under which it has been kept. In a hot dry atmosphere blood stains will dry out and become insoluble more rapidly than in a cold moist environment. Thus, a blood-stained garment thrown over a hot radiator or exposed to the hot rays of the summer sun may become denatured within a relatively short time, and then it will not be possible to prepare a suitable extract for the precipitin test. For the same reason, estimates of the age of blood stains are of limited value only in medico-legal work. In general, one may consider a dried blood stain to be "fresh" if it still exhibits a brick red color, dissolves readily in saline solution, and the isoagglutinins in it have not deteriorated so that they can readily be demonstrated in extracts of the stain.

At times, the tests may disclose the presence of human blood even though no blood stains are recognizable or evident to the eye. For example, we have found that saline washes of old rusty blades have occasionally given unexpected positive reactions for human blood. Similarly, extracts of a dirty mop or rag may disclose the presence of human blood. Such extracts should be clarified by centrifugation, and brought to a neutral pH before testing, because chemicals such as ammonia interfere with the precipitin reaction.

The fact that so little material is needed to elicit a positive chemical and precipitin reaction makes these tests particularly valuable in homicide cases. One case is recalled where a child had been hit by a truck which deserted the scene of the accident, leaving the child's dead body lying in the street. The police combed the neighborhood garages and found a truck which had a tire with a small stain on it. This six-foot wheel was brought to our laboratory, and in one of the grooves of the

immense tire, a small glistening red black spot about the size of a pea was seen. This stain dissolved readily in saline solution and the extract gave positive reactions for human blood. It is also routine practice of the police department to jack up automobiles suspected of being involved in vehicle homicides, and to examine the under-carriage for pieces of human tissue and blood stains. Not infrequently small fragments are found, saline extracts of which give positive reactions for human blood while histological sections show the presence of skin, fat and other tissue. Occasionally, we are asked to examine bullets for the possible presence of blood stains, in order to determine whether the bullet has passed through a human body. It would seem that if a bullet had passed through a body and was embedded in a wall that any traces of blood would be rubbed off. In fact, we had not found any demonstrable blood stains on any of these bullets, until recently when one day a bullet was brought in with a pin-head, red-brown crust in the concavity at one end of it. This stain dissolved readily in saline solution and gave positive reactions for human blood.

Blood Grouping Tests on Dried Blood Stains

Although directions for performing blood grouping tests on dried blood stains are simple, such tests are among the most delicate and difficult of serological procedures. The greatest danger in performing these tests is that of misinterpreting the reactions observed. Inexperienced workers have a tendency to take the reactions at face value and to interpret them accordingly. One case may be cited to illustrate this point.

Case 5. A robbery was committed by a man while he was under the influence of alcohol. He cut himself on a broken window, and left a trail of blood from the scene of the crime to his home where he was found by the police in a drunken stupor in a Morris chair. A technician examined the dried stain at the scene of the crime and showed that it contained human blood, and that the stain weakly clumped known group A cells but failed to clump known group B cells. Based on these results he testified at the trial that human blood of group B had been found at the scene of the crime. The defense attorney then announced that the defendant was willing to submit to a blood grouping test. This test showed the defendant to belong to group O, which had been known by the defense attorney all along from the defendant's dog tag. This was a jury trial, and the judge then requested one of us to clarify the situation. It was pointed out that negative reactions in an examination of dried blood stains are hardly ever conclusive,

because of the possibility of deterioration. The failure to demonstrate anti-B did not necessarily imply that this agglutinin had been originally absent from the blood stain. The presence of anti-A excluded group A and group A-B, leaving open the possibility that the stain came from a group B or group O individual. Significantly, in tests by the absorption method, the dried stain failed to neutralize either the anti-A or anti-B testing serums. The defendant was convicted.

The examination of dried blood stains is generally restricted to the four A-B-O groups, and consists of two parts, the test for isoagglutinins and the test for agglutinogens. Due to the limited amount of material available, it may not be possible to do a complete examination in every case. When deciding which tests to undertake, one should therefore take into consideration the amount of stain available, the state of preservation and the fact that the isoagglutinins are more labile than the agglutinogens. The technic used should vary with the nature of the stain and the article on which the stain is found. On nonabsorbent surfaces, such as knives and glass, the blood tends to dry in crusts, in a form convenient for the cover slip method of testing for isoagglutinins. On absorbent materials, such as clothing, the absorption test for agglutinogens is the procedure of choice, but when ample fresh stain is available an extract should also be prepared and tested for its isoagglutinin content.

In the cover slip technic, paradoxically, the best results are obtained with thin, small blood crusts. The thinner and smaller the blood stain the more rapidly will it dry, and the better its state of preservation. Large pools of blood generally dry slowly, allowing time for bacterial growth and putrefaction. Moreover, clots may retract expressing the serum, so that the isoagglutinins may not be found in the colored part of the stain. Moreover, a thick blood crust prevents the cover slip from lying flush on the slide, so that the conditions are not favorable for the test. In performing the cover slip test, one places a number of thin blood crusts on the slide. A drop of the fresh blood suspension of standard A_1, B, or O cells,* respectively, is added to the blood crust on three such separate preparations, and then cover slips are dropped over each mixture immediately, before the stain has a chance to go into solution. After the preparation has stood for a few

* Cells of subgroup A_1 are preferable to random group A cells, because cells of subgroup A_1 are more agglutinable than cells of subgroup A_2.

minutes at room temperature, it is examined for agglutination of cells adjacent to the blood crusts, under the low power of the microscope. Using these precautions we have obtained gratifying results with this test.

For demonstrating isoagglutinins in large blood stains on cloth, the following method has often proved successful in our hands. A portion of the blood-stained cloth is cut out and placed in a wide test tube. Just enough saline solution is added to saturate the stained cloth, and the dark discolored saline solution is then expressed from the cloth by prodding with a glass rod or other device. The cloth is then allowed to reabsorb the fluid and this process is repeated a number of times. The dark extract obtained in this way is clarified by centrifugation at high speed, and the clear but dark supernatant fluid is tested for its isoagglutinin content as follows: Into each of three tubes, 5 to 10 drops of extract are placed, depending on the amount of blood stain extract available. To the first tube is added one drop of a 0.5 percent fresh suspension of group A_1 cells, to the second tube a drop of group B cells, to the third tube group O test cells are added as a control. After thorough mixing, the tubes are allowed to stand in cracked ice for 5 minutes, and then centrifuged in chilled centrifuge cups containing cracked ice at 1,000 r. p. m. for 2 minutes, in order to sediment the cells. The supernatant dark fluid is rapidly decanted and a drop of saline solution is added to the sediment of each tube, the tubes being kept as cold as possible during all the manipulations. The tubes are then gently shaken to dislodge the sediment and the reactions read with the naked eye and under the low power of the microscope. The dark supernatant fluid recovered from the tests may be used to repeat the tests, should this seem desirable.

Directions to Police Officers for Handling Blood-stained Evidence

Opportunities to obtain worthwhile results are often lost because of improper handling of the evidence before it reaches the laboratory. In one case where important blood grouping results were obtained, the defense attorney brought out the fact during the trial that all the articles had been placed into the same carton. The lawyer thus successfully conveyed the implication to the jury that the blood stains had been trans-

ferred by contact from one article to another, even though the detective insisted that the stains were dry when the articles were placed together in the carton. Sometimes, a blood-stained knife is wrapped in paper and when the wrapping is removed in the laboratory the blood stains are found on the paper and not on the knife. Obviously, in such cases the detective had wrapped the knife while the blood stain was still wet.

In order to increase the value of the blood-stain examinations in homicide cases, therefore, the following directions have been prepared to guide detectives who collect the evidence at the scene of the crime and bring it to the laboratory.

Principle. Bacteria may destroy blood stains, especially those kept at body or room temperature. If a cloth with a wet blood stain on it is rolled up, this will favor the growth of a mold. Excessive heat and excessive cold may damage a blood stain, the former being more detrimental. The ideal temperature for preserving blood stains is refrigerator temperature.

Directions for handling dried blood stains on nonabsorbent surfaces. Remove the dry stain by gently prying up some of the crust by means of a clean, dry scalpel or knife, and place in a small envelope or pill box. Do not remove all the stain from the area. If the object is removable, this should be delivered at once to the laboratory, together with the removed blood crust. If the stains are on a nonremovable object, e. g., wall, floors, etc. a representative unstained section as well as the section which supported the stain is removed by gouging or digging it out. These specimens are to be placed in separate clean containers and delivered to the laboratory as soon as possible, together with the dry blood crust. If the nonremovable section is glass or a polished clean area where there is no absorption or penetration of the stain, no control area is essential.

Moist or partly dried blood stains. Dry the stains *quickly* and *completely* by means of waving in the air and/or directing a fan in the area. The dried stain is then handled as already described.

Liquid blood stains and blood clots. Use a dry clean dropper to take up some of the stain or use a clean, dry test tube to scoop up some of the stain. The stain picked up with a dropper or pipette is placed into a clean dry test tube and sealed. The sealed tube is then placed in a beaker or container of cracked ice. The remainder of the stain is *completely* and quickly dried

by waving in the air or directing a fan on the area. It is then handled as described above. The liquid and dry specimens are both delivered to the laboratory as soon as possible.

Comment

Blood grouping test on suspensions of erythrocytes are simple, and the interpretation of the reactions is generally unambiguous. Thus, if anti-A serum clumps erythrocytes the presence of agglutinogen A in the erythrocytes may be inferred, while failure of agglutination to occur is evidence for the absence of agglutinogen A. (Rare exceptions to this statement exist. For example, blood of subgroup A_3B orA_4 may fail to react with the usual anti-A reagents.) The situation is quite different when examining blood stains, since not only is the technic more exacting, but the interpretation of the reactions is frequently difficult and may require considerable insight and experience. For example, in tests carried out by the absorption technic, failure of the blood stain to absorb (or neutralize) the anti-A testing serum is not sufficient to prove that the stain does not contain agglutinogen A, because of the possibility of denaturation. Moreover, when the stain is small or dilute and the testing serum too strong the absorption may be incomplete. On the other hand, complete neutralization of the anti-A reagent by a blood stain does not necessarily prove the presence of the agglutinogen A in the stain, because on a soiled garment, for example, sweat, bacteria, and other interfering substances may inhibit the reactions, as can be shown by tests on the cloth adjacent to the blood stain.

The only reliable way of proving that a stain contains group O blood is by demonstrating the presence of both isoagglutinins anti-A and anti-B either by tests on blood crusts by the cover slip method, or by testing extracts of the stain. Group A and group B can be diagnosed most readily by the absorption technic, because one of the two antiserums will be neutralized while the other will not, so that such results have an internal control. Group AB is the most difficult and most dangerous diagnosis to make on a dried blood stain, because this is based on the failure to demonstrate isoagglutinins in the stain, a negative and therefore an inconclusive finding, and by the ability of blood stain to neutralize *both* testing serums anti-A and anti-B, so that the possibility of a non-

specific effect is difficult to exclude. In general, more refined diagnoses, such as differentiating dried blood of group B from dried blood of subgroup A_2B are hardly possible. In view of these considerations, it is not surprising that we have found it possible to arrive at a definite diagnosis of the blood group for only a minority of the dried blood stains which we have examined.

The neophyte who is unfamiliar with the niceties of blood grouping of dried blood stains tends to fall into the trap of interpreting the reactions too literally. In fact, there seems to be an inverse relation between the experience and understanding of the investigator and the readiness with which he reports results of blood grouping tests on dried stains. This is illustrated by the following case from Queensland, Australia, concerning which we were consulted at the beginning of the year. According to the story, a man had been accused of murder, and a light smear of blood was found on his towel. This was examined by a local bacteriologist, who apparently had had no previous experience with blood stains. The bacteriologist reported that the stain consisted of human blood of group AB, and this was said to be the same blood group to which the murdered man belonged. Since the accused belonged to group O, and the towel was the property of the accused, the evidence looked black indeed against him. Snippings of the towel were mailed to us and the following is a summary of our own findings and interpretation:

"It was obvious on inspection that there was not enough stain for blood grouping tests. Group AB is one of the most difficult blood groups to establish in a dried blood stain even under ideal conditions. In fact, in tests on hundreds of blood stains every year it is rare that we venture a diagnosis of group AB. The fact that a relatively inexperienced worker has made this diagnosis on such unfavorable material indicates that he has probably fallen into the trap of interpreting reactions observed in these tests too literally, and has failed to use adequate controls. In this connection one should read the case report on page 420 of the book, Blood Groups and Transfusion, 3rd ed., 1943, C. C. Thomas, Springfield, Illinois.

"In fact, it was found impossible to establish whether or not the stain on the toweling is of human origin. While the reduced phenolphthalein test was consistently positive, indicating the probable presence of blood, nonspecific clouding when the extract was layered over normal rabbit serum and foaming of the extract suggests the presence of a detergent which interferes with the precipitin test, and would likewise interfere with the reliability of any blood grouping tests.

"Our final conclusion therefore is that the stains probably do contain blood, but because of their small size and the presence of some interfering substance it is not possible to determine whether or not the stains are of human origin; nor is it possible to determine the blood group."

The serologist charged with the responsibility of grouping dried blood stains can avoid errors only by being extremely critical of the results he obtains. In this type of work, the "blind test" has proved invaluable to us, since only by this method can blunders be avoided (11).

Summary

In the serological laboratory of the Office of the Chief Medical Examiner of New York City hundreds of blood-stained articles are examined annually in homicide cases. This paper deals primarily with certain principles and practical aspects of the tests and the interpretation of the findings, which cannot be found in text books on the subject.

The blood grouping tests are most valuable if the blood stains are still fresh and wet when found, because such stains can be classified completely for all the known blood factors. Such opportunities are rare; however, a few illustrative cases are described. Generally the blood stains are already dried when found, and frequently they are in poor condition because the articles on which they occur are badly soiled and contaminated with bacteria. When examining such dried stains the grouping tests are necessarily limited to the four A-B-O groups, and even so, positive results are obtained in only a minority of cases.

Some general principles regarding the chemical and precipitin tests for human blood are discussed, and a few cases described which illustrate the value of these tests. The tests have been particularly valuable in hit-run automobile homicides. With regard to the technic of grouping dried blood stains, methods are described which have given satisfactory results in our hands, for testing for isoagglutinins in blood crusts and in blood stains on cloth. Also included are instructions for police officers for handling blood-stained articles so that they may reach the laboratory in optimal condition for examination.

The limitations and pitfalls of blood grouping tests on dried stains are discussed. It is pointed out that the neophyte has

a tendency to interpret the reactions too literally, and is too ready to report positive results. Two cases are described which illustrate serious blunders committed by such beginners, and it is pointed out that such errors can be avoided by using proper controls and the blind test.

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The Spectrographic Identification of Noxious Elements (Thorium and Silicon) in Biopsy Tissues

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The histological examination of tissues removed surgically may demonstrate granulomas whose structure is not sufficiently characteristic to specify the causal agent responsible for the tissue reaction. Tubercles, other similar chronic granulation tissues and scars may be caused by a variety of bacteria, lipids, or noxious metals and other elements. Some of those substances reduced to granules and engulfed by phagocytes challenge identification when microchemical tests fail to give characteristic reactions. Our report emphasizes the value of the spectrographic analysis as a means for disclosing the unsuspected presence of noxious metals or elements, responsible for granulomatous lesions or scars. The histological examination of three surgical tissues mentioned disclosed scar and other tissue reactions, which in themselves, were not sufficiently characteristic of a specific agent, but which by spectographic analysis were found to contain noxious elements responsible for the lesions.

Methods for the spectrographic analysis of tissues: A 1.5 meter emission spectrograph [*] with a multisource power supply was used. Samples of materials are excited electrically on carbon electrodes to produce light of specific wave-lengths which are spectrally separated with a diffraction grating and

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[*] This equipment was purchased through a grant given by the Women's Board of St. Luke's Hospital.

photographed on a 35 mm. film. When compared with known spectral lines on a standard film in a densitometer, the presence of many elements even in trace amounts is established. The density ratio of the spectral lines of a particular element to those of an internal standard forms the basis for a quantitative measurement when the analytical procedures are so standardized.

Tissue samples were dried at 120° C. and 1 gm. of the dry tissue with a few drops of concentrated sulfuric acid was ashed at 530° C. The ash was dissolved in 1 ml. of a solution containing the internal standard, buffer substance, hydrochloric and nitric acid. An aliquot of 0.15 ml. of the solution was placed in the crater of a ¼ inch graphite electrode and dried at room temperature for about 30 minutes. The electrodes were placed in a 105° C. oven for 1 hour and arced in an 8 ampere D. C. arc for 17 seconds according to the method of Butt, Nusbaum, Gilmour and Didio (1).

Report of Cases

Tissue 1. Thorium in scar tissues of the neck: A 41-year-old white male truck driver was admitted to St. Luke's Hospital on June 3, 1955 in the care of Doctors Paul Holinger and Kenneth Johnston because of hoarseness and a sore throat. These began suddenly on April 16, 1955 and were accompanied by a dull ache in the right suboccipital region of the neck and a dysphagia with dry foods. Swallowing and deep breathing were associated with a radiating pain in the right side of his neck. Direct laryngoscopy on May 13, 1955 revealed a gross swelling of the right arytenoid cartilage that continued into the right aryepiglottic fold. The posterior pharyngeal wall had a scirrhous lesion of the mucosa which extended into the right hypopharynx. The vocal cords and left pyriform sinus were not involved. The right pyriform sinus was red but not ulcerated. Carcinoma was suspected. Biopsy tissues removed from the right pyriform sinus consisted of a hyaline scar with focal clusters of large mononuclear phagocytes containing a greenish yellow, coarsely granular pigment. The pigment did not react with the microchemical tests for iron. The histologic examination however, demonstrated that the biopsy tissues were inflammatory and not neoplastic. The pigmented granules in the phagocytes were regarded as extraneous but were not identified (Figure 1) in the small amount of tissues removed.

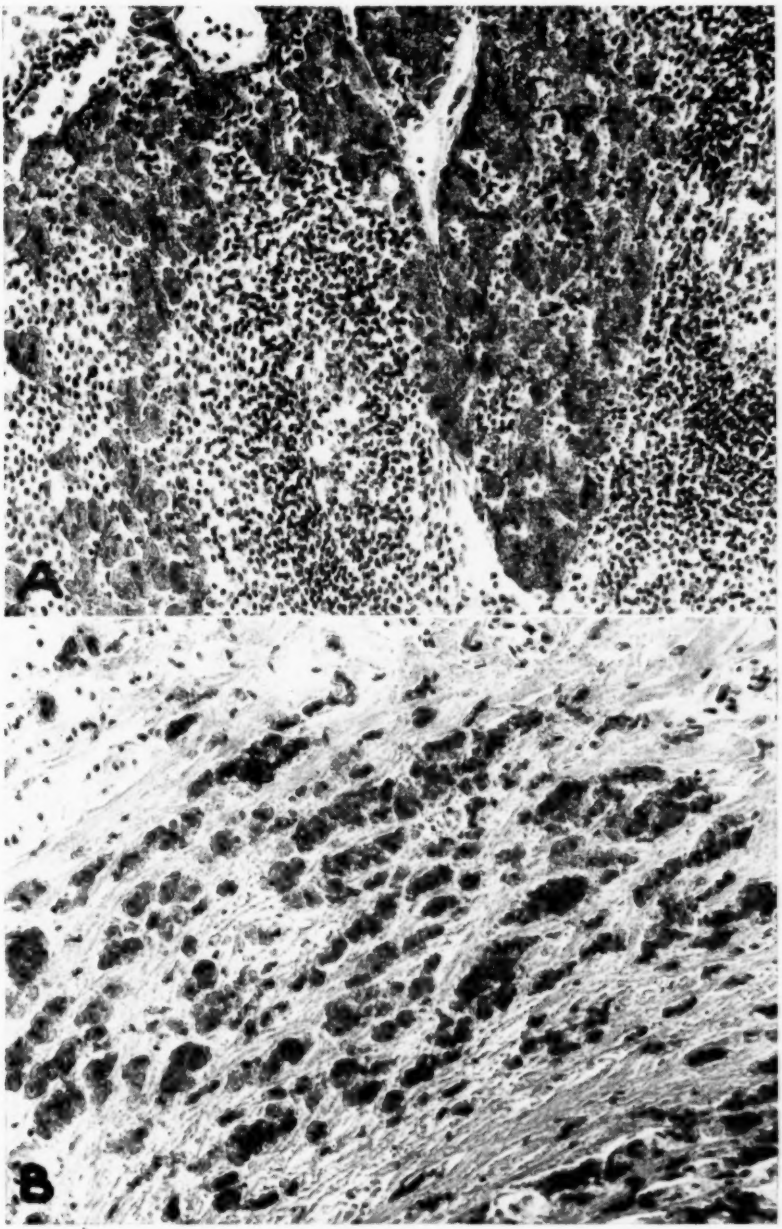

Fig. 1—Photomicrographs illustrating (A), deposits of coarsely granular thorium pigment in reticuloendothelial cells of a lymph node, and (B), dense hyaline collagenous scar tissue with deposits of coarsely granular thorium pigment in mononuclear cells and free in the tissue (Tissue 1).

Physical examination further demonstrated a small, tender immovable mass deep in the right side of the neck. The blood had 4,570,000 erythrocytes and 7,050 leukocytes per cubic mm.; the hemoglobin was 13.4 gms. per 100 ml. Of the leukocytes, 20 percent were lymphocytes, 5 were monocytes, 66 were polynuclear leukocytes, 4 were eosinophils and 5 were band cells. The urine had a specific gravity of 1.010 and a pH of 5.5. There was no albumin or sugar and the sediment contained no erythrocytes or leukocytes. The blood nonprotein nitrogen was 23.5 and the sugar 90 mg. per 100 ml. The Kahn and VDRL tests of the serum were negative.

Roentgen films revealed opaque tissues in the right side of the neck which obscured much of the bone and soft tissue detail, but did not displace the trachea. They extended from the aortic arch to the level of the mandible but not beyond the midline.

After the histological examination had demonstrated the inflammatory nature of the biopsy tissues, Doctors H. W. Southwick and K. Johnston on June 6, 1955 surgically exposed and removed much of an irregular mass of dense fibrous tissues that completely surrounded the right common carotid artery and vagus nerve and extended into the strap muscles, lateral wall of the pharynx, and transverse processes of the cervical vertebrae. Histologic examination of these tissues demonstrated that they contained bundles of skeletal muscle fibers infiltrated by dense hyaline collagenous scar tissues with focal deposits of gray-brown or green-brown, coarsely granular pigment. The granular pigment was in large mononuclear cells and occasionally free in the scar tissues. A small lymph node had similar intracellular deposits and a hyperplasia of the reticulo-endothelial cells (Figure 1).

Less than 1 gm. wet weight of unfixed tissue was available. Samples were digested in a mixture of sulfuric acid (0.5 ml.) and percholic acid (1.0 ml.) over a flame. Following this digestion a white precipitate separated. The liquid portion and the white precipitate were analyzed separately with the spectrograph. The precipitate yielded an especially strong spectral line for thorium. The presence of thorium was then demonstrated by chemical analysis of the precipitate obtained with other samples of the tissue digested by the sulfuric acid-perchloric acid mixture. The precipitate was easily soluble in diluted acids (hydrochloric and sulfuric) but soluble only

in an excess of concentrated sulfuric acid. When the precipitate was dissolved in diluted sulfuric acid, addition of sodium fluoride produced a precipitate of thorium fluoride which was insoluble in concentrated nitric acid. When a portion of the original precipitate was dissolved in diluted nitric acid, the addition of hydrogen peroxide and potassium iodate formed another white precipitate (thorium iodate or thorium potassium iodate) (21).

Significant radioactivity was demonstrated in the original precipitate by means of a Geiger counter.*

After thorium had been demonstrated in the biopsy tissue by these methods the patient was questioned and a review of records from another hospital disclosed that difficulty had been encountered in injecting thorotrast eight years previously for an arteriogram of the right internal carotid artery.

Tissue 2. Talc granuloma **: A white female, age 59 years, entered St. Luke's Hospital on April 13, 1951 with a history of nausea and vomiting and a loss of 58 pounds in weight during the preceding one and one-half years.

Eleven years before admission, during a laparotomy, adhesions about the gallbladder were broken. In order to determine the nature of her present abdominal disorder an exploratory laparotomy was advised. This, on April 17, 1951, disclosed numerous small and large gray nodular masses on the peritoneal surfaces and omentum associated with extensive fibrous adhesions. These peritoneal nodules grossly were thought to be carcinoma and tissues were removed for histologic examination. The nodules consisted of fibrillar, fibrous and fat tissue with many small and large lipid vacuoles, surrounded by clusters of foreign body giant cells and large mononuclear phagocytes. Some of the giant cells had inclusions of refractile material which, with the micropolariscopic examination were needles with double refractive properties. There were also masses of concentrically arranged hyalinized fibrous tissue centrally with small crevices (Figure 2). Spectrographic examination of the tissues in the paraffin block revealed the presence of an appreciable amount of silicon.

* Radioactivity studies were made by Warren Wells in the Department of Biochemistry, The University of Illinois, College of Medicine, Chicago.

** Reported in detail by Willis G. Diffenbaugh, M.D. in Gastroenterology, Vol. 25, 296–299, 1953.

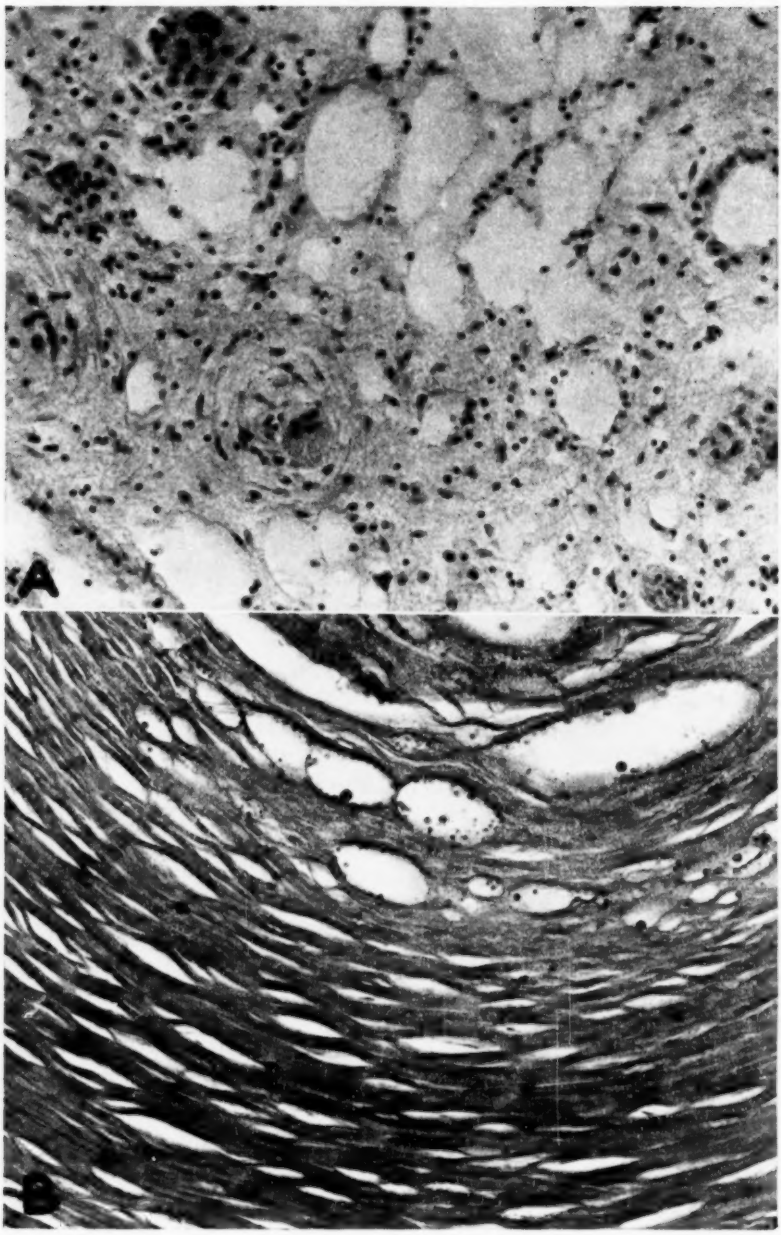

Fig. 2—Photomicrographs illustrating (A), fibrillar, fibrous, and fat tissues with lipid vacuoles surrounded by clusters of foreign body giant cells and large mononuclear phagocytes, and (B), masses of concentrically arranged hyalinized fibrous tissue (Tissue 2—Talc granuloma).

This result with those of the histological examination established the diagnosis of talc granuloma.

Tissue 3. Silicosis and tuberculosis: A 59-year-old Negro sandmill operator entered St. Luke's Hospital on June 14, 1955 because of an asymptomatic lung shadow found during a routine roentgenogram of the chest. Except for a blood pressure of 220/120, the physical examination was essentially negative. On June 22, 1955 the anterior segment of the right lobe of the lung was removed with the possibility that it was cancerous. Histologically the lung tissues were inflammatory. They had single and confluent rounded masses of chronic

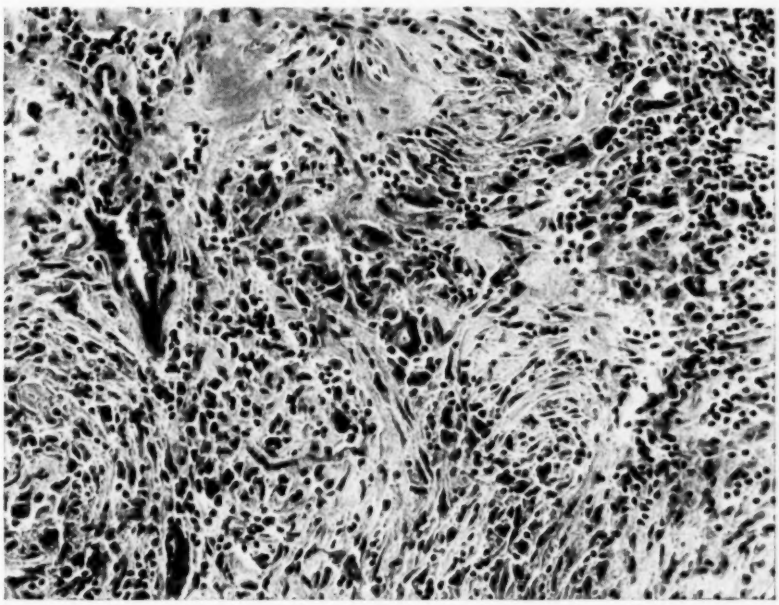

Fig. 3—Photomicrograph of lung illustrating chronic granulation tissue with fibrillar stroma, ephthelioid cells, lymphocytes and multinucleated giant cells (Tissue 3—silicosis and tuberculosis).

granulation tissues with a large amount of fibrillar stroma, epithelioid cells, a moderate number of lymphocytes, multinucleated giant cells, and needle-like refractile inclusions (Figure 3). Spectrographic analysis of the tissue revealed excessive amounts of silicon. Acid fast bacilli were found in the histologic sections and in three samples of sputum during

the first ten days after surgery. Thus, the diagnosis of silicosis associated with tuberculosis was established.

Discussion

Thorium: Thorium dioxide in a stabilized emulsion designated as thorotrast is used as a radio-opaque medium in angiography, hepatolienography, encephalography and ventriculography. Thorium is a naturally occurring radioactive element which disintegrates slowly into a series of radioactive substances releasing alpha particles, beta rays, and gamma rays. The total radioactivity reaches a minimum at the end of five years and attains a value of 54 percent of maximum in 10 years and nearly 90 percent of maximum at the end of 25 years due to accumulation of other radioactive substances of this series. According to calculations, one dose (75 ml.) of thorotrast is equivalent to 1.37 micrograms of radium. This approaches an amount (2 micrograms) known to cause serious radium poisoning (2, 3).

Thorium remains in the body for many years, if not indefinitely. The lesions produced in tissues may result from the toxicity of the metallic salts themselves as well as their radioactivity (4).

Local tissue changes may occur when thorotrast is injected into the perivascular structure as accidentally occurs during an arteriography. Prezyna, Ayres and Mulry (5) described a firm gray-yellow tissue mass enveloping the median nerve and brachial artery in the anticubital fossa, composed of atrophic skeletal muscle and large amounts of dense poorly cellular fibrous tissues. Basophilic, highly refractile granules largely concentrated in macrophages and sometimes free were scattered in the tissues. The granules did not respond to the microchemical tests for phosphate or iron. The presence of thorium was established by spectrographic analysis. A Geiger-Muller counter revealed significant radioactivity in the anticubital region of the arm and radioautographs of the excised tissue showed alpha particle tracks arising from an area of intracellular thorotrast granules. Subsequent questioning of the patient revealed that thorotrast had been injected 12 years previously in a study of the peripheral blood vessels.

Amory and Bunch (3) reported thorotrast reactions of seven patients who had perivascular injections of thorotrast

in attempted angiography, six involving the neck and one involving the arm. One patient had a painful swelling in the right submaxillary area with some dysphagia. Biopsy revealed dense fibrous tissues containing pigment considered to be lipochrome. During the next four months the mass increased in size and the tissues became indurated. Dysphagia increased markedly and the larynx was displaced to the right and fixed. Operation about three years later revealed a dense fibrous mass including muscle and fascia with interspersed yellow-white gritty material. Spectrographic analysis revealed the presence of thorium and other studies revealed radioactivity. Jones (6) and Baker and Karavitis (7) also reported cases with "tumor" and granuloma of the neck following injection of thorotrast.

Five years after intravenous injection of 75 ml. of thorotrast Jacobson and Rosenbaum (8) found large masses of grayish-green granules regarded as thorium in portal areas, sometimes free in fibrous tissue and also in phagocytes and Kupffer cells of the liver. The spleen had large collections of granular material in and about atrophic splenic corpuscles, near trabeculae, sheathed arterioles and in reticulo-endothelial cells. A lymph node near the gallbladder had large masses of granular material in the reticulum. No fibrosis or thorium was found in the marrow. A Geiger counter demonstrated radioactivity in the ashed liver tissue.

Aplastic anemia was attributed to the radiation effect on the hematopoietic tissue by thorotrast in a patient who died nine years after injection. A dark gray pigment was found in the marrow, liver, spleen, and lymph nodes and radioactivity was demonstrated in the marrow and spleen (9). Sarcoma of the liver and severe aplastic anemia were thought to be due to thorotrast in a patient dying twelve years after injection. Thorotrast was found in the liver, bone marrow, spleen and lymph nodes (10). Tissues examined ten and nineteen years after injection of 72 and 75 ml. of thorotrast respectively for study of changes of the liver revealed thorium dioxide in the liver, spleen, bone marrow and shaft of the femur, and adrenal cortex and medulla of one patient. Except for contraction with marked fibrous tissue replacement of the spleen in one patient, there was little tissue reaction or destruction. One patient died of chronic leukemia (16).

Silicon: Compounds of silicon may be deposited in tissues as talc, silica, glass, asbestos and other substances. Pure talc is hydrated magnesium silicate ($H_2Mg_3Si_4O_{12}$). The finely pulverized commercial talcum powder contains, as impurities, calcium magnesium carbonate, calcium magnesium silicate and other related substances (11). Silica is silicon dioxide and it occurs as sand, sandstone, and when crystallized as quartz, tridymite and cristobalite. Glass is a mixture of sodium and calcium silicate often with other silicates added. Asbestos is calcium-magnesium metasilicate.

Particlesize, chemical structure, solubility, and composition and degree of hydration of material leached out of the silicon compound by the tissue fluids are factors that influence the tissue reaction to these substances.

Talc crystals have been found in adhesions and tuberculous-like lesions of the peritoneum; scars, sinus tracts and lesions of the skin; granulomas of the eye, cervix, rectum, gallbladder, and gastroenteric stomas. Lesions may appear in the immediate postoperative period up to 36 years later (12, 13, 14).

Tissue reactions to talcum powder are variable. A hard mass 12 cms. in diam. was found in an eleven-year-old appendectomy scar originating in the external oblique aponeurosis. It consisted of closely spaced small tubercles formed by epithelioid cells, multinucleated giant cells and a few lymphocytes without caseation necrosis and surrounded by strands of cellular connective tissue. Needle-like inclusions found in some of the giant cells were considered to be calcium magnesium silicate (an impurity of talcum powder) (11). A foreign body reaction with multinucleated giant cells, round cells and vascular fibrous connective tissue immediately around double refractile crystals were included in criteria for selection of cases for a report on talcum powder granuloma (14). Lichtman and McDonald (15) point out that talc particles less than 0.5 microns in size produce an epithelioid response and that larger particles produce a granuloma, where as particles more than 10 to 12 microns in size are engulfed in foreign body giant cells without surrounding reaction.

Inhaled silicon dioxide (silica) produces firm gray coalescing nodules of dense hyalinized fibrous connective tissue in the lung (silicosis), and often crystalline silica can be seen

microscopically. Similar changes occur in regional lymph nodes and pleura. Much less common are silica granulomas of the skin (17).

Lack of correlation between the concentration of silica in pulmonary tissue and the degree of tissue reaction is due to the method of expressing silica in terms of percent of total ash. Since values for total ash increase as the disease progresses, the silica content expressed as percent of total ash is misleading. However, when silica is expressed as total weight of silica in the lung, it correlates well with the observed tissue reaction (18).

The rate of reaction to quartz in the body is inversely proportional to particle size. Particles 10 to 12 microns in diameter provoke a foreign body reaction with little progress in one or two years. Rapidly progressive tissue changes occur with particles 1 to 3 microns in diameter, and an even more acute reaction with death in 1 to 8 months occurs with particles 1 micron or less in diameter. According to Gardner (19), silicon dioxide is capable of exciting every tissue response that can be produced by mycobacterium tuberculosis.

Vorwald and Landau (20) injected mice with saline suspensions of various duct particles 1 to 3 microns in diameter in studying the influence of dusts on tuberculosis infections. All forms of free silica produced late lesions characterized by necrosis and fibrosis. Dusts of silicates and non-silicious minerals produced groups of mononuclear cells filled with dust particles and often a peripheral zone of inflammatory cells but necrosis and fibrosis were not conspicuous during the extent of the experiment (about 2 months).

Comment

The usefulness of an emission spectrograph in disclosing noxious metals or elements in surgical tissues is emphasized in these reports. In each tissue the spectrograph disclosed the nature of the exogenous substance responsible for the lesion. Spectrographic analysis of surgical and necropsy tissues frequently can reveal significant amounts of unsuspected noxious metals. The emission spectrograph thus enables the detection of these elements or metals and establishes the causal agent of the lesions found by histological examination.

Summary

An emission spectrograph was used to establish the nature of exogenous material found microscopically in surgically removed tissue from three patients. Thorium was identified in pigmented scar tissues of the neck and silicon was identified in a peritoneal talc granuloma and a lung with pneumoconiosis.

The tissue reactions following the introduction of thorium and silicon compounds are briefly discussed.

The value of spectrographic analysis of tissue lesions is emphasized.

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THE PROBLEM OF LEAD POISONING: To avoid danger to small children, manufacturers of toys and cribs have been careful for years now not to use paints containing lead pigments. Parents interested in the purchase of "lead free" paint should pay attention to paint labels—adequate except where the terms "chrome-yellow," "chrome-green," or "chrome-orange" camouflage the considerable content of lead chromate in these pigments. Unless the declaration on the label clearly excludes lead content, yellow, orange, or green colors are not recommended for refinishing in children's rooms.

Another source of lead poisoning is inhalation of lead fumes from the burning of storage battery boxes. Forty cases of acute lead poisoning, mostly among children, due in all probability to inhalation after storage battery casings had been used for fuel by poor families, were discovered in a study by the Baltimore City Health Department in 1932. The dangerous fuel had been distributed free or at little cost by junk dealers after lead plates had been salvaged from discarded storage batteries. Later reports of similar situations came from other cities, such as Detroit and Philadelphia.

Lead poisoning in children differs considerably from lead poisoning in adults. Encephalopathy or central nervous involvement, seldom seen in adults, is common in children, with poor prognosis and high mortality rate. Peripheral neuritis, lead line on the gums and colic are usually absent. Roentgenographic evidence of lead deposition appears as abnormally dense bone at the growing ends of shafts of long bones and along growing margins of children's flat bones. From "What's New," #187, 1955, Abbott Laboratories, Chicago, Ill.

Some Implications and Results of the Psychiatric Treatment of Inmates*

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In September 1950, the first prison program attempting large scale, dynamic psychotherapy came into being at the California Medical Facility on Terminal Island. Recently, after this program had been in operation for four years, a statistical survey comparing California Medical Facility parolees with a similar group of parolees from other prisons was completed. The survey concluded that the rate of parole suspension of California Medical Facility parolees was less than half that of parolees from other prisons.

For one year I had the privilege of working as a therapist on the clinical staff of the California Medical Facility. I want to discuss this program and the premises on which it is based, and to suggest some implications of these results. I want to emphasize at this point that I am not talking about criminals in general, but inmates. There is reason to believe that there may be significant differences between criminals at large who are never caught and inmates who are caught time and time again.

The major premise upon which the program at the California Medical Facility is built is that a significant proportion, perhaps most, of the inmates are emotionally disturbed individuals whose criminal behavior is a symptom of their psychopathology.

Modern abnormal psychology recognizes groups of emotionally disturbed individuals, called "instinct-ridden characters," "impulse neurotics," and "neurotic characters" whose

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lives are characterized by behavior that serves to relieve unconscious tensions rather than to adapt conscious needs to external reality. They repeatedly and blindly perform acts or undergo experiences that represent unconscious attempts to dissipate intense anxiety. For these persons the environment is an arena in which to stage internal conflicts, rather than a setting in which conscious inner needs are legitimately and satisfactorily fulfilled. Incapable of tolerating the anxiety produced by not gratifying their impulses immediately, they make a way of life out of impulsive, irrational behavior that temporarily reduces the overwhelming feelings of tension they would otherwise experience. The gambler, the Don Juan, the alcoholic, are all individuals like this. The criminal differs only from these types in that his impulsive, irrational behavior is proscribed by law. The psychological function and meaning of his behavior, however, is the same. It is irrational, it is impulsive, it serves to reduce inner tensions and anxiety rather than the realistic adaptation of inner needs to external realities. High rates of recidivism yield bleak testimony to its repetitive nature. There is frequently the same quality of irresistibility—of lack of conscious reasonable control. Although, as in the case of the noncriminal neurotic, the behavior may be rationalized—or even idealized—when the rationalizations are examined they do not satisfactorily explain the impetuous, illogical, dangerous, destructive, basically unsatisfying qualities of the criminal act. Economic motives may be professed by the thief, burglar or armed robber, for example; but it is a fact that most of these crimes involve relatively small amounts of money as compared with the risks taken. The check-writer almost insures his being caught when he signs his own name to a fraudulent check. The sex offender usually experiences little or no sexual gratification from his act, which frequently seems manifestly unreasonable because there are available other sexual outlets that do not involve the risk of legal retaliation. Many criminals will admit that they do not understand what impels them to crime. Though not all inmates are of this type, many appearing overtly psychotic, the bulk of these who had previously been shrugged off as untreatable psychopaths fall under these above categories. Much criminal behavior, then, can be looked upon as the translation of unconscious emo-

tional conflicts into ways of behaving that superficially may seem illogical, but that have meaning and function in terms of the unconscious emotional life of the individual. This is the premise of this paper, and, indeed, of the psychotherapy program at the California Medical Facility.

Traditional prison programs aimed at punishment (an attempt to impose a conscious deterrent), or social rehabilitation (attempting to change group identifications or vocational adjustment) have not been effective in preventing recidivism. They *cannot* be effective because they do not come to grips with the underlying psychological problem. Unconscious motives are frequently more compelling than any fear of punishment no matter how severe. The training of superficial attitudes or vocational skills, no matter how enlightened and humane these programs may seem, will not resolve emotional conflicts. Humane treatment with educational or vocational opportunities are and must remain an important part of any modern prison program. However, as long as the underlying psychological determinants of criminality remain untouched, the psychological problem that drove the individual to commit his first crime will frequently drive him to repeat his criminal act again and again. Only through a rational psychotherapeutic approach can the psychological basis for crime and recidivism be treated.

These ideas about the role of unconscious motives in criminal behavior are not new. But a functioning program based on this orientation is new. While the results of the California Medical Facility program do not justify a categorical statement that *the cure* for recidivism is psychotherapy, the striking drop in the rate of parole suspension of California Medical Facility parolees is compelling evidence in favor of this approach to the treatment of criminality.

The California Medical Facility is a penal institution primarily of medium security, housing some 1,100 inmates. Three hundred elderly men are housed in a minimum custody annex outside the prison walls. Of the remaining 800 men about 600 are actively involved in the therapy program. These psychotherapy patients form a very heterogenous group, with respect to both psychiatric diagnosis and criminal offense. Psychiatrically, they include almost all varieties of character disorders, psychoneuroses and psychoses, with the

majority, perhaps, classified as character disorders. The "instinct-ridden character," "impulse neurotic," "neurotic character," fall under this latter category. Legally, almost all crimes are represented. These prisoners were sent to California Medical Facility for many different reasons—because they requested treatment, because they were disciplinary problems in other prisons, because their pattern of recidivism made them a poor parole risk without treatment, because their criminal behavior seemed directly related to an emotional disturbance. Many were initially sent as part of a work crew or at the convenience of the Department of Corrections, but became involved in the treatment program during their stay.

The general therapeutic atmosphere, generated by the very fact that 600 men are simultaneously attempting to come to grips with emotional problems, is usually enough to induce almost all new arrivals to enter therapy groups within a few weeks. Therapy was and remains one of the main preoccupations of that inmate population; it extends far beyond the group meetings. Inmates walking the yard or sitting around their wards in the evening spend hours discussing therapy and their individual problems with one another. Prisoners are thought of as patients and treated as patients, with therapeutic considerations playing an important part in questions involving housing, work and school assignments, and discipline.

Although discipline is humane, in accordance with the general philosophy guiding the operation of prisons in this state, the use of the term "therapeutic atmosphere" does not imply that prisoners are indulged or impulsive behavior permitted. They are not coddled. To the contrary, it is an important part of psychotherapy in this setting that reasonable custodial limits are firmly enforced. A disciplinary policy that would permit impulsive behavior by inmates would run contrary to the goals of treatment. It is a *necessary* part of treatment that patients learn to tolerate the frustration and anxiety of not acting impulsively.

"Therapeutic atmosphere" *does* mean that prisoners' irrational attitudes toward, and fantasies about, authority figures are not justified and reinforced by the behavior of the custodial authority. The patient, who has a pattern of provoking

authority figures into harsh, punitive, retaliatory measures that enable him to feel justified in his own aggressive antisocial behavior, is frustrated by the firm but reasonable behavior of the custodial staff. Similarly, the patient who harbors the fantasy that an obsequious, overcompliant "good little boy" attitude will bring special rewards is also disappointed by the carefully impartial custodial attitude. The frustration and anxiety aroused by discipline of this kind is brought into the therapy group, where fantasies and attitudes like these become conscious grist for the psychotherapeutic mill. This rational, therapeutic disciplinary policy is an important part of treatment; and it is as difficult to maintain as it is important. Inmates can be skillfully provocative. However, in order that irrational fantasies and attitudes about authority be exposed and changed, it is important that the authority resists being drawn or goaded into behavior that could be used by inmates to reinforce their irrational attitudes.

Some by-products of this therapeutic disciplinary policy are an unusually relaxed prison atmosphere (the absence of tension in the yard is frequently remarked on by visitors), a low rate of disciplinary infractions (though among these prisoners are some of the biggest troublemakers in the state), and an increase in the patients' anxiety about their behavior that serves as a vehicle for insight and change.

Most of the psychotherapy is done by a clinical staff of six therapists—two sociologists (therapists with a social work background), two psychiatrists and two psychologists. The chief of the clinical staff is Dr. Nathaniel Showstack, who has directed the program from the time of its inception. Therapeutic techniques are continuously under evaluation and development in weekly supervisory conferences led by Dr. H. Michael Rosow, who spends one afternoon each week at the prison. Treatment occurs in groups of eight to ten men who are usually seen twice weekly in sessions of an hour to an hour and a half. Some patients are treated individually when this is indicated.

It should be emphasized that therapy groups are *not* classes in mental hygiene and do not discuss moral issues or any other topics as such. Patients are not lectured, exhorted to reform, reasoned with or impressed by the therapist with the

error of their ways. Therapists are not "good guys," indulgent parents or authoritarian figures. Although, on occasion, therapists will intercede in the administration of prisoners, they do not act as intermediaries who represent the prisoners, but act only as advocates of the realistic therapeutic policy. This is a psychotherapy program, based on the same principles that guide dynamic psychotherapy in private or other institutional settings. Although specific therapy techniques are modified to fit the type of patient and the realities of a prison situation, the theoretical principles remain the same.

Group psychotherapy has not only the advantage of being economical, in that one therapist can treat as many as 60 to 100 patients, but may be the treatment of choice for most offenders. Unlike the neurotic, whose conflicts cause him to suffer with internal symptoms such as anxiety and depression, the criminal's symptoms are expressed in the unconsciously determined distortions of reality reflected in all of his interpersonal relationships. These distortions and irrationalities are not limited to the criminal act; criminal behavior is only one of many manifestations. A wide range of conscious attitudes and expectations are colored by the pervasive influence of the same unconscious motives and conflicts that lead to criminal behavior. In the therapy group, by continually being confronted with the irrational attitudes, expectations, fantasies that appear in his behavior in relation to other patients and the therapist, the patient becomes more and more aware of these irrational components of his feelings and behavior. This process is not an easy one. It is frequently tedious and painful. Confrontations of this type are frequently met with bitter denials, angry outbursts or bland attempts to cover up and deny all. Patients will avoid facing feelings and the anxiety they arouse by storming out of groups, acting out homosexually, and fighting. Often it takes months of patience and persistence before a patient can tolerate the anxiety aroused by a single confrontation. It took almost a year before one young desperado could trust his therapist enough to attend groups regularly. As the therapist and group persistently pointed out that this patient's toughness and bravado were a sham, and that he really wanted to be liked, even by the custodial officers for whom he affected a violent hatred, the patient grew more and more anxious. In

one tense and dramatic session, after he admitted that he had always felt lonely and rejected, even by his own family, the patient wept bitterly in the group. He did not come to the next group session, and before another one had passed, he was in administrative segregation for having become involved in a homosexual triangle. It was clear that this homosexual activity was his way of avoiding what he feared most—his growing feelings of warmth toward and dependence upon the men in his group and his therapist. Unfortunately, this man continued to get into trouble whenever he was released from segregation, thereby preventing the continuation of treatment. Some men cannot tolerate the anxiety created by greater awareness of the threatening feelings that motivate irrational behavior. In those who can, however, this greater awareness tends to dampen impulsive behavior. As anxiety becomes consciously connected to its real source—the emotional conflict—it no longer impels irrational behavior.

In the honest but supportive and understanding atmosphere of the group, the offender—frequently for the first time in his adult life—can face the irrationality of his behavior and learn to tolerate his anxieties about weakness, aggression, dependency, adult sexuality without feeling compelled to—or being able to—cover over these feelings with criminal behavior. Frequently, for the first time he can let himself feel close to others and let himself want to be close, satisfying his deep needs for love and security in a more direct fulfilling way. The therapist becomes a surrogate parent or sibling with whom a new therapeutic relationship can serve to undo the pathogenic effects of distorted familial relationships.

Some individual cases may illustrate the changes that occur:

Jim, a middle-aged man in prison for molesting his daughter, is notably passive, eager to please and compliant in the therapy group. As his passive behavior is continuously pointed out to him, Jim speaks of his feelings of inadequacy, his fears that he cannot be a strong man, and his fears of asserting himself. He recounts his anxious fantasies that he cannot satisfy a woman sexually, that his penis is too small, and his related feelings of inability to be strong and self-assured with his wife. She has always been dominant in the family, since Jim imagines that if he were to assert himself

she would reject him and leave him. As Jim becomes aware that he is passive because he fears that to be assertive will mean rejection, he becomes more and more anxious. The anxiety signals the appearance in consciousness of long-dormant angry feelings toward his wife and others whom he feels have demanded compliance. Jim sweats out this mixture of anxiety and rage. He bitterly accuses the group and the therapist of trying to make him submit to them. The group and therapist still accept him despite his anger and irrational accusations. Jim begins to understand that these demands come from within himself, that others do not demand passive compliance of him, and that his hitherto unconscious fantasies, not his wife, were to blame for his meekness. Gradually over a period of many months, he becomes more assertive in the group, and much more confident of his new-found strength. Since Jim can now feel and act the role of a man, as he feels a man should be, he will no longer need either to seek out a child as a sexual outlet or act out his unconscious aggression towards his wife using her daughter as a tool.

Fred was a 28-year-old armed robber who fancied himself a tough gunman and a Don Juan. Sullen, rebellious and hard when he came to California Medical Facility he was difficult to manage from a disciplinary viewpoint and resistant to therapy. His cynicism and tough facade colored all of his participation in the therapy group. He took obvious pleasure in telling the group detailed stories about his many sexual conquests. The group, rather than gratifying his wish to be feared and admired, pointed out his strong needs to impress and intimidate the other men. As his usual methods for evoking fear and respect failed, Fred grew more and more anxious. It was pointed out to him that he must have many fears of weakness and that his hard, cynical attitude was his way of denying his fears of unmanliness and inadequacy. Only by intimidating others and keeping them from getting too close could he quell his fears of being forced into a position of submission and subserviency by other men whom he feared, inwardly, were stronger than he. It took many months of patient acceptance and nonretaliation to Fred's hostility before Fred could trust the group enough to discuss his fears of weakness and recognize the defensive nature of his behavior. Fred gradually became aware that although he acted the

part of a Don Juan, his sexual affairs were permeated with anxiety and guilt. He had never before understood the periods of impotence and sexual inadequacy that he experienced. Growing more and more anxious, at one point he cried, "The only time I felt like a man was when I had a gun in my hand." A couple of sessions later he remembered that he had experienced premature ejaculations before each of the three armed robberies he participated in. The panic these sexual failures created, the feelings of impotence and weakness they stimulated drove Fred to commit the armed robberies where, with a gun in his hand, he could feel like a man. As Fred began to recognize that what he had valued, even idealized—his toughness, his boastfulness, even his career as an armed robber—only served him as a camouflage to hide his fears of weakness, his whole bearing, tone of voice and even his facial expression changed. He began to accept the needs for tenderness and warm close relationships he had hitherto felt to be a sign of weakness when he could feel respected and liked without having to play a role. He lost his need to act aggressively and was no longer a disciplinary problem. He began to participate in the prison athletic program and enrolled in educational courses from which he derived real satisfaction and pride in his achievements. Since he was no longer afraid, he no longer felt compelled to act a role that he felt would make him feared.

Although the treatment of inmates with psychotherapy is frequently difficult, usually lengthy, and sometimes disappointing, the positive results of the program at California Medical Facility—the significant drop in the rate of recidivism, the results with patients like Fred and Jim—imply that psychotherapy is a rational treatment for recidivism. A further confirmation for this conclusion can be drawn from the results of continued treatment of parolees on an outpatient basis. Of 100 parolees being treated in an outpatient clinic at the end of a year of operation, only five had their paroles suspended, and *none* of these five were convicted of having committed new crimes.

Conclusion

If time and more research continue to affirm our original premise—that inmates are emotionally disturbed men who

need treatment—will time also bring changes in the administration of the law? Perhaps the day may yet come when offenders will be committed to a hospital-prison for treatment, rather than sentenced for punishment or reformation. If recidivism can be successfully reduced by psychotherapeutic programs, it may be a lot cheaper in terms of both money and human suffering to treat inmates as patients rather than as detainees who must do time, time that is so frequently as profitless for the inmate as it is expensive for the community.

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Book Reviews

EFFECTS OF ALCOHOL ON THE NERVOUS SYSTEM OF MAN, by Cyril B. Courville, M.D., Director, Cajal Laboratory of Neuropathology, Los Angeles County Hospital and Professor of Nervous Diseases (Neuropathology), College of Medical Evangelists, Los Angeles, California. San Lucas Press, Los Angeles, 1955. 102 pages.

This important and vital contribution is the result of the report by the author and associates of previous studies with the problem of alcoholism. The importance of this subject not only from the sociological point of view but from the neuropathologic studies warranted an expansion of this work into the present monograph. There are 13 chapters in this book and each section follows in a logical sequence beginning with an historical introduction of the subject. Although the problem of alcoholism has been known for a very long period of time, the understanding of the pathogenesis and pathology of alcoholic disorder of the nervous system is of relatively recent observation. For example, in 1881 Wernicke and Stewart described encephalitis hemorrhagica superior and in 1892 Korsakoff described the pathologic findings of chronic alcoholic psychoses. The more detailed histopathologic analyses of the changes in the cells in the brain came at a later date (1931). The author further develops the subject of alcohol as a medical problem. And here again it is quite obvious the impact acute and chronic alcoholism has on the social economic structure. It is one of the greatest of all hazards to life and death. In the chapter on alcoholism and medical problem the author comments on the relation between alcohol and injury and he states that in Los Angeles County about 33% of traffic victims had been drinking just before the fatal accident.

The immediate and primary effect of alcohol on the body tissues is that of a narcotic and this is illustrated by its inhibitory action on the functions of the individual cells. It is said

that the action may be 6 times as great on the nerve cells as compared with other cells of the body owing to the fact that these elements are so highly sensitive to the influence of extraneous noxious substances. The author concludes that the ultimate effect of alcohol on the individual nerve cells of the brain and spinal cord occurs to the mediation of multiple complex mechanisms whose individual components supplement and reinforce each other to produce both immediate and delayed necrobiotic alterations. The author in each of the chapters correlates the changes that take place in other parts of the body with those seen on microscopic examination of the central nervous system. For example, he is of the opinion that the cellular and circulatory changes incident to acute alcoholic intoxication, whether as an isolated episode (drunkenness) or as one superimposed on chronic alcoholism already complicated by liver damage (fatty change or cirrhosis), are essentially transitory and reversible ones. An important observation made as a result of these studies indicates that each individual alcoholic insult to the vulnerable brain is not marked by any recognizable change in the individual nerve cells, slowly and imperceptibly these elements are undergoing punishment that many of them cannot forever withstand.

In his discussion on Wernicke's hemorrhagic encephalopathy the author believes that the train of characteristic lesions in the grey matter about the 3rd and 4th ventricles and cerebral aqueduct may be a consequence of the presence of alcohol in the cerebral spinal fluid, but its actual genesis is probably due to an associated avitaminosis. There follows a discussion on the changes that involve the peripheral nerve as well as discussion on alcoholic atrophy of the cerebral cortex. There is a progressive atrophy of the cortex of the frontal lobes in the dorsolateral surface as a result of repeated alcoholic episodes or of chronic alcoholism. This is illustrated by both gross and microscopic study. In relationship to Korsakoff's psychoses which is a syndrome associated with chronic alcoholic psychoses the author is of the opinion that it is the result of chronic alcoholism plus the effect of progressive degenerative arterial change, a result of repeated insults of alcoholic intoxication advanced by progressive ischemia incident to arteriosclerosis.

There is a very interesting discussion on post-alcoholic commissural and central necrosis of the brain referred to as Marchiafava-Bignami disease. This was first reported in Italy and it was believed that it is characteristic for a particular racial group. However, subsequent anatomic studies of the brain made in other locations including the United States have reported incidents of similar observation. The inference of this interesting pathologic alteration of the brain is that it is the result of malnutrition with avitaminosis, attendant on chronic alcoholism. It is apparently seen among those who drink crude Italian red wine and there is a possibility that there may be an additional toxic element in the wine itself. There is a discussion on alcoholic cerebellar degeneration, regressive changes in the spinal cord incident to chronic alcoholism, alcohol and other lesions of the nervous system, and the final chapter labelled "An Epitome," in which the subjects previously discussed are reviewed succinctly.

Although there is comment in general terms on the question of the quantity of alcohol in the blood and cerebro-spinal fluid there is no attempt to correlate the toxicologic analyses of alcohol and the various kinds of alcohol with the pathology of the central nervous system. The author states very clearly the initial amount of alcohol ingested may have varying effects on tissue cells, and this is illustrated by photomicrographs. The photographs, both gross and microscopic, are clear, well reproduced; the format is good, the type easy to read. A most interesting observation is that the author with very few exceptions has made hemotoxolyn-eosin stains of the tissues examined and was able to record detailed cellular changes. This should be of interest to the pathologist because it is assumed that one must make special stains in order to observe the cellular detail in the central nervous system. The bibliography is a good one and the index is adequate.

This book is highly recommended to all physicians, particularly to pathologists, and especially to the forensic pathologist who so often has occasion to study these changes and the relationship these findings may have on the over-all concept of legal medicine.

CLINICAL TOXICOLOGY, by Clinton H. Thienes and Thomas J. Haley. Lea and Febiger, 1955. 3rd Edition. 457 pages. Illustrated. $6.50.

The third edition of this book has been enlarged but still follows the format of previous editions. It has been written as a classroom text and for that purpose it fulfills its purpose. As a guide for the general practitioner it presents a difficulty in the use of the index which has in many cases too many page references, although bold type is used to indicate the more important one. Such cross references [as "Lysol—see Cresol" and then "Cresol—see Phenol"] detract from ready usage, particularly since such a book is expected to be used for finding information rapidly. About two-thirds of the book is given to description of the drugs and the symptoms, pathology produced, treatment recommended, etc., but since the drugs are considered under general headings, one finds a bit of repetition. Nevertheless, the material is well presented in a concise manner. Tests for the poisons make up the rest of the book. Many of the tests can be carried out in a hospital laboratory or emergency room, with a minimum of equipment. Most of the common poisons are considered, and sufficient information is given.

The book, printed on excellent paper, is easily readable and singularly free of typographical errors. Charts and plates are clear. It is worth while and should be available in emergency rooms. Physicians will find it factual, but perhaps a bit too heavy to carry as a handbook, and the index somewhat disturbing.

THE POWER OF POISON, by John Glaister, Professor of Forensic Medicine, University of Glasgow. William Morrow & Co., 1954. 272 pages with 6 illustrations.

This book differs from the ordinary case book of poisonings in that it is more than a repetitions recital of A poisoning B. Although some sixteen cases are considered, it is from the viewpoint of the personalities not only of the poisoner but also of the prosecutor, the defense, and the court, that the writing progresses. It is this thinking of the people involved that makes the book a worth-while study; although the cases considered date from 1752 to 1924, and the weaknesses of the

procedures used are properly evaluated, the basic considerations the author discusses are still valid. Establishment of proof and the strength and weakness of circumstantial evidence which must be relied on in cases of poisoning, since such crimes are usually secret, are given full and balanced consideration. The meticulous care needed in preparing such cases for presentation in court, either as prosecutor or defendant, is woven into the narration with contemplative care. The jury, its function and foibles, is given due thought. While it is true the book is written in a style understandable to the laity, and this can be of extreme educational value, it is sufficiently fundamental to be of value to those in the field of forensic sciences, who will find it fascinatingly interesting and informative. Sufficient references are given that one might follow in more detail the cases mentioned.

Articles to Appear in Forthcoming Issues of the Journal of Forensic Sciences

The History of the American Academy of Forensic Sciences—*R. B. H. Gradwohl*

Psychology of a Mass Murderer—*Ralph S. Banay, M.D.*

Some Legal, Economic and Social Aspects of Homicide in an Urban Area—*Robert C. Bensing; William B. Goldfarb; and Oliver Schroeder, Jr.*

Determination of the Time of Death by Body Heat Loss—*Herbert P. Lyle, M.D. and Frank P. Cleveland, M.D.*

Christian Science and Longevity—*Gale E. Wilson, B.S., M.D.*

Effective Expert Testimony and Compensation for Expert Witness—*Ordway Hilton, M.A., Donald B. Doud; and George E. Hall, J.D.*

The Incidence of Barbiturate Intoxication Observed at the Cuyahoga County Coroner's Office—*Irving Sunshine, Ph.D.*

Application of Blood Grouping to Derivative Citizenship—*Leon N. Sussman, M.D.*

Questioned Documents and Other Problems in Postal Law Violations—*James P. Kelley*

The Determination of Volatile Substances by Microdiffusion Analysis—*Milton Feldstein and Niels C. Klenshoj*

Differential Thermal Analysis: Its Application to the Study of Mineral Evidence in Scientific Crime Detection—*Roy H. Jevons*